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No. 5 ORIGINAL

In the Supreme Court of the United States

OCTOBER TERM, 1942

THE STATE OF COLORADO, *Complainant*,

vs.

THE STATE OF KANSAS AND THE FINNEY COUNTY WATER USERS' ASSOCIATION, a Corporation, *Defendants*.

BRIEF FOR DEFENDANTS

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I. Jurisdiction

This is an action instituted by the State of Colorado against the State of Kansas and one of its citizens, The Finney County Water Users' Association. Original jurisdiction arises under Article III, Section 2 of the Constitution. Leave to file the Bill of Complaint was granted on January 3, 1928. The controversy involves the equitable apportionment of the waters of the Arkansas River between the two states.

Testimony was taken before a stenographic commissioner appointed by this court until December 21, 1939, when both parties rested. Thereafter, the Honorable Charles C. Cavanah was appointed Special Master, and the case reopened for additional testimony. The report and recommendations of the Special Master were filed in the cause in May, 1943, and the cause is before the court on the exceptions taken to the Special Master's report.

II. Statement of Case

A. PLEADINGS

A very brief summary of the main issues as presented by the pleadings is as follows:

On January 3, 1928, the State of Colorado was granted leave to file its original Bill of Complaint in equity. Therein it was claimed:

A. That the waters produced in the State of Colorado belong to that state; and that the courts of the state forbid by rules of public policy, (1) recognition of claims, or (2) use of water outside the boundaries of the state. Claimed the right to use and distribute within its borders all of the waters originating and flowing therein to such of its citizens as it chose to select, without regard to the

claims of the citizens of any other state, including the State of Kansas, subject only to such limitations as the Supreme Court of the United States might determine to exist between the state and other sovereign states; and that the State of Colorado has assumed the responsibility in its sovereign capacity for such obligations, if any, as the state bears to other sovereignties.

B. That Colorado recognizes the necessity of maintaining and dealing with state rights on interstate streams as a whole, and that settlement of differences respecting irrigation matters is imperative between states.

C. That the suit instituted by Kansas about May 20, 1901, against Colorado, decided in 1907, adjudicated that the quantum of water represented by appropriations and diversions existing within the State of Colorado in the year 1907 was within the lawful rights of the state, and that the continuance of such appropriations and diversions was in legal effect quieted to the State of Colorado, its corporations and citizens.

D. That no material increase has been made in the depletions of the waters of the Arkansas River, and that the substantial interests of the State of Kansas

have not been detrimentally altered or the equitable apportionment of the benefits disturbed since said date.

E. That certain citizens of Kansas have engaged in litigation with private enterprises in Colorado, demanding recognition of certain priorities and delivery of water in accordance with said priorities; that suits involving determination of priorities are pending in the District Court of the United States for the District of Colorado; and that the continuance of such litigation should be enjoined.

F. That private rights which may exist within the State of Kansas for the use of water from the Arkansas River are derivated purely from the sovereignty of Kansas under such policy as is in force or which it may adopt, and that all such rights within the State of Kansas are to be allocated such quantum of water or use as the State of Kansas may be entitled to by equitable principles adjudicated by this Court.

G. That Colorado offers to do full equity to the State of Kansas in respect to the administration and use of the waters of the Arkansas River, and prays that the Supreme Court of the United States may reserve to itself sole jurisdiction, and protect itself in its sole jurisdiction over the determination of the use of the waters

of the Arkansas River as between the states of Colorado and Kansas, and may quiet the rights of the State of Colorado under the adjudication in *Kansas v. Colorado*, and give such relief as may be just and equitable.

After a motion to dismiss the Bill of Complaint, which was by the Supreme Court denied without prejudice to any question Kansas and The Finney County Water Users' Association filed their separate answers.

In these answers it was:

A. Denied that Colorado owned all of the flowing water of the Arkansas River and its tributaries within that state, and alleged that the same was an interstate stream and that the water must be shared equitably between the citizens and residents of Colorado and the citizens and residents of Kansas; and denied that the use of water for irrigation or other purposes in Colorado has been actually in subordination to the limitations that this Court has determined to exist as between Colorado and another state or states, and alleged that the conduct of Colorado has been without regard for and in violation of the rights of Kansas and of its citizens.

B. Denied that Colorado had assumed responsibility in a sovereign capacity for such obligations, if any, with regard to the water flowing in the Arkansas River, as it

bore to Kansas; denied that the claims that the use of water from the Arkansas River and its tributaries in Colorado for irrigation in that state constitute rights as against the State of Kansas or its citizens, and denied that under the administration of water by Colorado a uniform use with maximum economy and consideration of public welfare was maintained.

C. Denied that in the case of *Kansas v. Colorado* the Court determined that the quantity of water represented by the appropriations and diversions existing and carried on within the State of Colorado under its authority in the year 1907 was within the lawful rights of Colorado, or that such appropriations and diversions were by such decision in legal effect quieted to Colorado.

D. Claimed that certain ditches in Kansas were constructed, ditches begun, and water appropriated as follows: Garden City Ditch 1879, Finney County Water Users' Association 1880, South Side Ditch 1880, Great Eastern 1881, Fort Aubrey 1882, Alamo 1883, Amazon Ditch 1887, and Frontier Ditch 1892, but that on account of the increased taking of water from the Arkansas River and its tributaries, farming operations under said ditches were conducted with difficulty, and water was

inadequate for the purpose of successfully raising agricultural crops.

E. Claimed that the flow of water into Kansas from Colorado has been steadily and continuously diminished in all the period from 1880 to 1928, and that the development of irrigation in the State of Kansas has been obstructed, diminished and delayed; that most of the ordinary flow of the Arkansas River from Colorado into Kansas has been consumed in Colorado; that most of the water flowing by river from Colorado into Kansas has been from extraordinary rains on the plains, causing floods of short duration at each time; that Colorado by means of reservoirs has brought about increased taking of water from the River, has decreased the water supply to Kansas, and that large areas of land lying under ditches in Kansas, which could have been irrigated if water had been available, have not been irrigated for lack of water by increased taking of Colorado; that from the time of filing the Bill of Complaint in *Kansas v. Colorado* continuously until the time of the filing of the Bill of Complaint in this case, the amount of water taken in Colorado from the Arkansas River and its tributaries has been greatly increased, and that the depletion of the waters of the Arkansas River flowing

into Kansas has thereby greatly increased, with great injury to Kansas, and its citizens; and that irrigation of agricultural lands from the waters of the Arkansas River have been injured, obstructed and diminished.

F. That the issues and decision in the case of *Kansas v. Colorado* did not pertain to any questions of priority in the rights of appropriations of water, but only to a claim of Kansas to have the water allowed to flow by said River from Colorado into Kansas as it had naturally flowed; and that the Bill of Complaint was dismissed without prejudice to any Bill of Complaint by the State of Kansas pertaining to the flow of water from the Arkansas River into the State of Kansas.

G. The State of Kansas prayed that the court would protect and quiet the rights of the State of Kansas and its citizens to their apportionment of water in the Arkansas River for irrigation of lands in Kansas as against the acts of parties in Colorado who have later rights than those in Kansas; and that the rights of residents or citizens of Kansas to divert water from the Arkansas River for the purpose of agricultural irrigation in Kansas be decreed in second feet, and that the agents, residents and citizens of Colorado and the State of Colorado be perpetually enjoined from diverting any water

from the Arkansas River or its tributaries in Colorado until the rights of the citizens and residents of Kansas to divert water shall be satisfied; and be enjoined from diverting water to the injury of the rights of the State of Kansas, its residents or citizens, and for further relief as may be equitable.

The Finney County Water Users' Association in substance claims that its prior right to 250 second-feet of river flow as of December, 1880, be recognized and decreed as against the State of Colorado and its citizens diverting water from the Arkansas River and its tributaries.

Colorado replied to that part of the separate answer of the State of Kansas, praying for affirmative relief.

Colorado denies that the waters of the Arkansas River since 1901 have been further depleted by diversion and use in Colorado; alleges that the water supply crossing the state line available for use in Kansas has improved in quantity and character; and maintains that Colorado is not now taking more than its equitable share of the water supply.

A. Colorado alleges that the decision in the case of *Kansas v. Colorado* determined the rights of the two states in and to the waters of the Arkansas River to the

date and as of the date of the closing of testimony (1905), and alleges no question of law or fact remained undetermined in said cause, except such as might arise from events subsequent to the closing of testimony in that cause.

B. Colorado admits the construction and existence prior to 1901 of the Frontier Ditch, the Alamo Ditch, the Fort Aubrey Ditch, the Amazon Ditch, the South Side Ditch, the Great Eastern Ditch, The Finney County Ditch, and the Garden City Ditch, but alleges that none of the other ditches mentioned by Kansas in its answer ever reached completion or actually operated or diverted water in any real or substantial extent.

C. Colorado alleges that its land is sterile without irrigation, and that its people have spent vast sums of money in developing irrigation enterprises. Colorado also asserts that the inhabitants of the basin are entirely dependent upon the water of the River for a livelihood either directly or indirectly.

D. Colorado alleges that Kansas has little need of water from the Arkansas River for irrigation, but that rainfall is generally sufficient in Kansas for crop production. Colorado states that Kansas has done little to avail itself of water at its disposal; that Kansas has

built no reservoirs or storage facilities, with one minor exception; and that Kansas has not taken full advantage of the ground water available.

E. Colorado further alleges that Kansas is as a whole more prosperous than Colorado; that its agricultural resources are much more varied, and the western counties, even those bordering on the Arkansas River, have shown a gain in wealth and prosperity comparable with the remainder of the state; but on the other hand the Arkansas valley in Colorado, being dependent entirely upon agriculture based upon irrigation, has definite limitations to its development, and has grown in wealth and prosperity much less markedly than the Arkansas valley in Kansas, and is much less capable of definite expansion and improvement.

F. Colorado requests that that part of the "Separate Answer of the State of Kansas" praying affirmative relief be dismissed and that the prayer for relief in the original complaint herein made by the State of Colorado be granted with costs.

Under these pleadings the main issue raised is the equitable apportionment of the water supply of the Arkansas River between the states of Kansas and Colorado.

B. FACTS RELATING TO STREAM SYSTEM

"Course of the Arkansas River. It is one of the principal tributaries of the Mississippi River and it and its tributaries are non-navigable streams arising among the higher ranges of the Rocky Mountains and is formed by the junction of the branches known as East Fork and Tannesses Fork with Lake Fork, at a point near Leadville near the center of the State of Colorado, where the elevation approximates 10,000 feet above sea level. These headwater branches extend up to elevations of 10,500 to 12,000 feet at mountain passes across the Continental Divide, and up to 14,000 feet at the crests of the highest mountain peaks (*R. 68*) and it takes thence a southerly and southeasterly direction passing through the Royal Gorge Canyon to Canon City where the elevation is about 4,900 feet and about 100 miles below its source it passes through Canon City and Fremont County in Colorado. The area above Canon City is drained by small tributaries contributing to the stream the mountain runoff, where precipitation runs from 20 to 30 inches annually (*R. 426*). Its source in the vicinity of Leadville is in the higher range of the Rocky Mountains with a rapid descent until it enters the more pronounced canyon sections immediately below Salida and from there to Canon City it flows through a pronounced canyon section. After it leaves the Royal Gorge Canyon immediately above Canon City it enters through a more or less rugged country, being generally hemmed in by narrow valleys and foothills, and the character of the country is characteristic until it approaches

the City of Pueblo, where the valley widens out and the adjacent foothills recede, and from Canon City to Pueblo it lies at an elevation of approximately 4,300 feet and the fall of the river is about 15 feet to the mile (*R. 72*). It thence flows from Pueblo east to the Colorado-Kansas state line, passing through country where the topography is more gentle and tributaries entering from both sides (*R. 70*), and the fall of the river from Pueblo to La Junta averages 9 feet per mile, and from La Junta to the state line about 7 feet per mile (*R. 72*), and from there to Dodge City the fall of the stream is about 6.8 feet per mile (*R. 506*), and from Dodge City to the Oklahoma state line the average fall is about 5.5 feet per mile. The area of the basin in Colorado as drained by the river amounts to 25,258 square miles and the area in Kansas is approximately 18,238 square miles. Its length in the State of Colorado is about 320 miles and in the State of Kansas about 390 miles, and after entering the State of Kansas it flows through southwestern and south central part of that state, leaving the state at its southerly boundary to enter the State of Oklahoma and flows then for several hundred miles before reaching the Mississippi River." *Master's Finding of Fact Second* (Record references in italics ours.)

A list of the principal tributaries entering the stream in the 175 mile strip from Pueblo to the Colorado-Kansas line is as follows:

Entering from the North:

Name	*Tributary Length*	*Drainage Area*
Fountain River.....	66 miles	930 sq. miles
Chico Creek.....	57 miles	795 sq. miles
Horse Creek.....	87 miles	1,177 sq. miles
Adobe Creek.....	53 miles	751 sq. miles
Big Sandy.....	150 miles	3,145 sq. miles

and entering from the South:

Name	*Tributary Length*	*Drainage Area*
Saint Charles River...	40 miles	498 sq. miles
Huerfano River.....	80 miles	1,765 sq. miles
Apishapa River.....	80 miles	1,090 sq. miles
Timpas Creek.....	35 miles	440 sq. miles
Purgatoire River.....	135 miles	3,390 sq. miles

(Colorado Exh. 32, R. page 493).

Of the above stream listed, the Fountain, the Saint Charles, the Huerfano, the Apishapa, and the Purgatoire all have their sources in the high mountain areas.

In addition to the above major tributaries there are some two or three dozen miscellaneous streams entering from both sides, adding much to the broken character of the topography, and contributing to the River by surface drainage between Pueblo and the state line. Collectively these drain an area of approximately 5,777 square miles (Colorado Exh. 32, page 493).

The entire Colorado area of the basin might well be likened to a great fan, the tributaries forming the ribs, converging on the main ribs on the River channel, and

finally forming a single stream where it passes out of the state a few miles east of the town of Holly.

In Kansas the topography is no longer broken. The flood plain of the River itself is from one-half to three miles in width (R. 2361). On either side the surface rises to heights above the valley floor approximately 60 to 100 feet, and this surface then lies almost as level as a floor, but with enough gradient to insure satisfactory irrigation. In this region thousands of acres are topographically favored with respect to agriculture (R. 2338).

In marked difference to the area from Pueblo to the state line in Colorado, where tributaries are numerous and important, from the Kansas state line to Kinsley, Kansas approximately 160 miles, there are no tributaries which might supplement the stream flow in the Arkansas River whatever (R. 2268). It is only when we reach the vicinity of Larned, approximately 190 miles east of the state line, or 230 miles by river channel, that the first live tributary, the Pawnee, joins the River. (R. 1495). From this point to the southern line of Kansas, where the River passes into Oklahoma, a distance of about 100 miles, several streams contribute to the flow of the River.

> "In the mountainous region along the western boundary of the Arkansas River Basin the annual precipitation runs between 20 and 30 inches, which

> is principally in the form of snow, and going eastward to the plains region in Colorado, the precipitation in this area ranges generally between 11 and 16 inches, and passing further east to the area from the Colorado-Kansas state line to Dodge City, the precipitation ranges from 15 to 20 inches, and continuing east along the river and from where the first tributary in Kansas joins the main stream and then to the Oklahoma state line the precipitation increases 20 to 30 inches." *Master's Report, Finding of Fact Third, page 7.*

Taking the two areas which comprise the Arkansas River basin in Kansas and Colorado together, we have on both the east and west precipitation belts where the range of precipitation is above 20 inches, but in between lies a region both in Kansas and Colorado where rainfall is less than that amount in varying amounts. The United States government in its classification of land areas of the United States placed this region in what is known as the arid or irrigation section (R. 372). Where the rainfall belt is below 20 inches, that area is arid. Below 20 inches rainfall must be supplemented to carry on agriculture in a satisfactory manner (R. 2263). There is an area of precipitation where there is below 20 inches of rainfall lying generally east of the mountains in Colorado and west of a line drawn north and south through Dodge City.

While in this plains area of Eastern Colorado the rainfall, generally speaking, averages approximately three inches less annually than the rainfall in the arid region in Western Kansas, the characteristics are extremely similar—approximately five-sixths of the annual amount falling in the April to October period (Kansas Exhs. 10 and 11, pages 1413 and 1414). Annual amounts considered in relationship to crop needs month by month show only a fractional difference in the average monthly precipitation (Kansas Exh. 12, page 1414).

> "The mean average annual temperature in the Colorado area ranges from two to five degrees lower than in Kansas area and in Western Kansas the wind velocities are higher than in the eastern region in Colorado, which has an effect upon evaporation." *Master's Report, Finding of Fact Third, pages 7 and 8.*

C. THE SOIL IN RELATION TO AGRICULTURE

> "The soils in both Colorado and Kansas areas are well suited to irrigation, but the character of the soil in Kansas area, which contains more silt than in the Colorado area (*R. 2287*), will hold larger quantities of water without loss by deep percolation." *Master's Report, Finding of Fact Third, page 8.*

The more porous soils are those containing a high content of sand and not so much silt. In the more porous

soils such as exist in Colorado, plants find it easier to absorb moisture from the soils than they do in the more compact soils in Western Kansas. It is likewise true that evaporation is less in soils with higher sand content than in those with higher silt content, for the reason that with a given rainfall there is a more rapid percolation into the soil, and consequently more protection from the effects of wind velocity and temperature which bring about evaporation (R. 2287). As a result crops raised in the arid region in Kansas and Colorado without benefit of irrigation are strikingly similar (R. 2299; Kansas Exhs. 103 and 104, page 2295). The yields per acre are likewise substantially the same (R. 2313-2318). The somewhat higher rainfall in the arid area in Kansas does not result in naturally higher yields of the same farm crops. The fact that the yields are practically the same in both states in this group demonstrates that the higher rate of evaporation, wind velocity, higher temperatures and differences in soil conditions in Kansas operate to enable crops grown in Colorado under considerably less rainfall to secure as much benefit for plant growth from such rainfall as they do in the Kansas area (R. 2316).

D. IRRIGATION

> "Both states from their beginning have recognized the need of water for irrigation, and the using for that purpose of the public waters in their states." (*Master's Report, Finding of Fact Fourth, page 8.*)

1. Irrigation in Kansas

As early as 1868, Chapter 23, General Statutes of Kansas, 1868, provided authorization for the formation of corporations for the construction and maintenance of canals for the purpose of irrigation. Chapter 58 of the Session Laws of 1876 further amplified the right, by making it unlawful for any irrigating canal to take and use water in such manner as to interfere with or to diminish the supply of water flowing to or through any established irrigating canal, thus recognizing thereby the superior right of the prior appropriator. Chapter 133 of the Session Laws of 1885 provided for liens upon crops for water furnished through irrigation. Chapter 134 of the Session Laws of 1885 provided penalties for the injuries to irrigating canals. Chapter 115 of the Laws of Kansas 1886, Section 1, is as follows:

> "The right to the use of running water flowing in a river or stream in this state for the purposes of irrigation may be acquired by appropriation. As

between appropriators, the first in time is the first in right."

Under this law the method of obtaining a water right requires posting of notice with a claim of the amount of water to be diverted, the place of diversion, and the size of the canal (Sec. 3). The posting of notice at the place of diversion and filing with the county clerk was required (Sec. 3). Work was required to be commenced within sixty days, and prosecuted diligently to completion (Sec. 4B). By compliance with rules the claimant's right relates back to the time of posting notice (Sec. 4). The courts of the state were open for adjudication of disputes arising respecting rights.

Session Laws of 1891, Chapter 133, dealt exhaustively with use of water for irrigation, its application to beneficial use, the abandonment of the right. Distribution in order of priority was provided for and provision made for its enforcement. The Revised Statutes of Kansas, 1923, includes these acts under Chapter 42, Irrigation. (See Appendix A, Separate Answer of the State of Kansas.)

2. Recognition in Colorado

Colorado by its constitution recognized the need, and early by appropriate legislation provided for its development.

The obtaining of a water right in Colorado is initiated by filing a map and statement of claim with the state engineer (R. 1367). The applicant was required to file a plat showing the extent of the project, the amount of the appropriation, and the land expected to be irrigated, sometimes especially set out and sometimes not (R. 858). The applicant can make claim for any amount he thinks he can use (R. 1368). The second step is the construction of the project. The third step is the application of water to a beneficial use (R. 1367). This must be within a reasonable time, which may be a matter of 5 years or 10 years for a large canal.

The next step was to institute proceedings in the district court of the water users' particular district for an adjudication (R. 1372). Notice was served on all water users in the district (R. 863). No notice was given of such proceedings to the water users in other districts which are above it and below it (R. 1372), nor was notice of any kind given or required to be given to water users lower down on the stream and outside of the state of Colorado (R. 1372). Prior to the statute passed in 1923 water users in other water districts had no right to come into an adjudication in a district court other than their own (R.

860), and the only remedy afforded such water users in other districts was an action in a court of equity (R. 860).

These adjudications sometimes came years after the filing date (R. 1370), but on the doctrine of relation the date of the priority and the amount of water adjudicated related back to the date of the original filing (R. 1375). Since the decree is defined in second feet, diversion and application to beneficial use of canal capacity for a few days can serve as the basis of an adjudication. While a decree is fixed in second feet, there is no limit in acre feet other than the general clause of benficial use (R. 1375).

All the water decrees are filed with the state engineer, since he is the administrative head of water distribution in the state, and all water is distributed in conformity with these records.

3. Development of Irrigation

Although hundreds of pages of the record and many exhibits are filled with interesting statistical information and comparisons concerning the settlement, agriculture, and population in both states, this material is omitted from any statement of fact for the reason that it has little bearing upon any solution of the need for water in the arid Arkansas basin in Western Kansas or in Eastern Colorado.

The development of farming operations, except for irrigation, was a gradually westward movement: Eastern Kansas was developed before Central Kansas; Central Kansas was developed before Western Kansas. Western Kansas, particularly with reference to its dry farming, has sustained its great impetus during the last 20 or 30 years. Dry farming areas in Eastern Colorado followed those in Western Kansas, and the greatest impetus there has been within the last 20 years. Great areas of tillable land have not as yet been settled on. These are susceptible to the same degree of cultivation and are susceptible to the same productiveness and dry farming conditions as are those in Western Kansas (R. 5027).

The two decades 1860 to 1880 saw the beginning of irrigation in Colorado. From 1860 to 1870 numerous small ditches developed near mining camps. These largely were close to the stream, irrigated small tracts, and such agriculture as existed was largely for the purpose of furnishing such crops as were needed to supplement the need of a mining population. By the year 1870, 30,000 acres, and by 1880, approximately 60,000 acres, of land were being irrigated on the headwaters of the Arkansas and on or near the heads of tributary mountain streams (R.

1563-64). But in the plains area of both states irrigation by means of the large ditches, diverting water from the main channel of the river, really started in the decade 1875 to 1885.

In the period prior to 1884 the arid area from Pueblo in Colorado to Garden City in Kansas saw the beginning of larger ditch construction for irrigation. By that date five ditches of considerable importance were commenced in that area in Colorado. These were, the Oxford Farmers in 1867, the Keesee in 1871, the Rocky Ford in 1874, the Jones in 1875, and the Lamar in 1875. In addition, however, the Catlin, the Rocky Ford Highline, and the Bessemer, all commenced after the beginning of 1884, did acquire some earlier small priorities of dates prior to 1884.

In Kansas the Garden City ditch was commenced in 1879, the Farmers Ditch in 1880, the Great Eastern in 1881, and the South Side in 1881.

Ditch construction continued in both states up until the early 1890's. The application of water to the land under these large irrigation enterprises in Eastern Colorado was slow. In Districts 14, 17 and 67, which comprise the counties of Pueblo, Otero, Crowley, Bent and Prowers, the great irrigation counties of the Arkansas Basin, the acreage under irrigation by 1889 amounted to only 33,390

acres, according to the census of that year (Kansas Exh. 52, page 1507).

In Kansas the irrigated acreage approximated 60,080 acres in 1896 (Kansas Exh. 115, page 2355). To bring the development of irrigated acreage to date in the four Colorado counties just referred to, the acreage under irrigation had increased to 212,341 acres according to the irrigation census of 1902 (Kansas Exh. 52, page 1507). The total irrigated acreage in the Arkansas Basin in Colorado, according to the census of 1939, amounted to 469,535 acres (Colorado Exh. 196, page 6556). In Kansas in the area between the state line and Garden City the amount of land under irrigation remained comparatively static, with only 56,341 acres under irrigation in 1939, but of this amount only 29,239 acres were still attempting to maintain irrigation without the use of supplemental water secured from pumping plants.

Following ditch development there came a period of reservoir development in Colorado. The first reservoir was completed in 1895, and water first used therefrom in 1896. One more, the Great Plains system, was completed before 1901. By 1910 eight more were completed. Nineteen more were added between 1910 and 1920, and four subsequently. Of these, two were washed out, leaving 31

with a decreed capacity of 521,506 acre-feet (Kansas Exh. 65, page 1543). In addition to these, the Caddoa Reservoir across the channel of the Arkansas River has been authorized to be built at government cost. This one reservoir has a contemplated capacity of 655,000 acre-feet, and a present completed capacity of 270,000 acre-feet. In Kansas one reservoir, Lake McKinney, was constructed and put in operation in 1909.

Transmountain projects capable of diverting approximately 250,000 acre-feet of water per year are contemplated, surveyed and under consideration by Colorado (R. 1453). Ultimately they might secure as much as 300,000 acre-feet (R. 1456).

4. Water Supply Available for Irrigation

> "The average annual natural flow of the River and its tributaries is 1,240,000 acre feet, of which the average annual dependable and fairly continuous water supply and flow of the Arkansas River and its tributaries is 1,110,000 acre-feet." (Master's Report, Finding of Fact Sixth, page 10.)

The foregoing fact is the result of the only determination of the complete water supply of the entire basin in Colorado, which appears in the record (R. 1442 to 1519; Kansas Exhs. 18 to 62, inclusive). This covers a 36-year period. The average dependable flow of 1,110,000 acre-

feet annually was arrived at by excluding excessively high water years, 1900, 1905, 1914, 1915, 1921 and 1923 (R. 1521), in line with the pronouncement of this Court made in the case of *Wyoming v. Colorado*, 259 U. S. 419, at page 476; 42 Sup. Ct. 552, at page 561. (See, also, Master's Finding of Fact Six.)

The character of this supply roughly falls into two classifications—First, the mountain runoff, largely resulting from melting snows in the high mountain areas, and impounded in those regions until released for use in the late spring and early summer; approximately 75 percent of the water supply falls in this classification, which is largely produced in conformity with irrigation needs during the summer months (R. 1419; Kansas Exh. 55, page 1510). Second, the remaining portion of the water supply, approximately 25 percent (Kansas Exh. 55, page 1510), is that which can be classified as plains runoff; this is largely the result of heavy rains on portions of the plains area. Precipitation in the plains area is largely erratic; runs off quickly without restraint (R. 1419). The contribution to stream flow follows almost immediately after the rain, and in many cases bears no relationship to the seasonal needs of crops for water. Colorado being the upper state, the irrigator in Kansas secures water from

river flow during the growing season, only when the needs of all Colorado irrigators have been satisfied or when reservoir storage is filled, or else when there is such flash flow in quantity for a few days in the River that (Colorado) canal capacities are insufficient to divert it either for irrigation or storage purposes (R. 1527).

The situation is well stated by State Engineer Hinderlider, who pointed out:

> "Practically all of the water escaping out of this valley into Kansas is the result of tributary flow entering the River in the lower reaches of the valley." (R. 1739.)

The day by day river flow recorded at the Kansas-Colorado line during the period from 1912 to 1931 is accurately portrayed by hydrographs (Kansas Exhs. 71 to 90, inclusive, pages 1618 to 1684). These show that out of 3,340 days making up the total of the growing season, 1905 days had a flow across the state line of less than 100 second-feet, and of these 1,359 days had a flow of less than 50 second-feet.

E. CONTROVERSY RESULTING FROM RIVER DEPLETION BY COLORADO

The controversy with respect to the waters of the Arkansas River has been of a continuous nature from 1901 down to the present. In 1901 the State of Kansas instituted suit in the Supreme Court of the United States against the State of Colorado, seeking to enjoin the diversion by the latter state of the water of the Arkansas River. Kansas claimed the right to the continual flow of the stream. Colorado claimed the right of ownership to all the waters arising within the state. The result was that the contentions of both parties were disapproved, and the court announced for the first time the doctrine of equitable apportionment of benefits of the water supply of an interstate stream. The case was "dismissed without prejudice to the right of the plaintiff (Kansas) to institute new proceedings whenever it shall appear that through a material increase in the depletion of the waters of the Arkansas River by Colorado, its corporations, or citizens, the substantial interests of Kansas are being injured to the extent of destroying the equitable apportionments of the benefits between the two states resulting from the flow of the river."

Following this decision, on or about August 27, 1910,

suit was instituted by the United States Irrigating Company in its private capacity against certain irrigation ditches in Colorado in their private capacity seeking to secure recognition through its facilities as against Colorado ditches diverting water. This case was dismissed after a contract had been entered into and a sum of money paid to the contracting parties, giving to them a decree as of the date of 1910. This contract had nothing to do with the question of the apportionment of the water supply between the states of Kansas and Colorado. The states of Kansas and Colorado were not parties to the contract. Furthermore, this contract was not consented to or approved by the State of Colorado nor by the State of Kansas (R. 5992). Neither was The Finney County Water Users' Association a party to this contract. On November 27, 1916, The Finney County Water Users' Association filed suit in equity in the United States District Court for the District of Colorado against Colorado ditches, seeking to compel recognition of a priority of 250 second-feet of flow as of the date of 1880. On January 23, 1923, the same character of action was filed in the same court against other ditches and reservoirs in Colorado. These cases are at present pending; and are the cases against which an in-

junction is sought in the present case to prevent their further prosecution.

In 1921 in Colorado, and in 1923 in Kansas, legislation was enacted providing for an interstate commission and the appointment of commissioners looking to settlement of the interstate controversies. Considerable work was done and investigations made almost entirely relating to the construction of a reservoir on the Purgatoire River in Colorado which might serve the purpose of storing water for use in Kansas. These compact negotiations failed for various reasons, but, as Mr. Knapp testified, this compact met with rather determined opposition from two sources in Colorado: First, from the canals on the main stream below the mouth of the Purgatoire that then were enjoying the waters of the Purgatoire who would be deprived of such waters; and second, from the interests on the upper portion of the Purgatoire, because of the fact that the proposed compact would prohibit the building of any further reservoirs on the Purgatoire by Colorado interests above Trinidad except for municipal purposes (R. 5288). As a matter of fact neither Colorado nor Kansas approved the report of the commissioners appointed by both states to investigate the matter.

F. MASTER'S REPORT

On May 24, 1943, the Special Master appointed by this Court filed his report and recommendations, and on the basis of his consideration and a review of the entire record found the main issues as follows:

(a) That the real issue involved in the present case is the equitable apportionment of the water supply of the Arkansas River and its tributaries in such manner as to secure as nearly as possible to each state irrigation without depriving either of the beneficial effects of a flowing stream, and to grant to each state relief and protection of their equitable portion of the water supply with certainty and definiteness as to the quantity, continuity and character, as is measured out to them at a definite place, so that delivery can be compelled. (Conclusion of Law One, page 14.)

(b) That since the taking of testimony in the case of *Kansas v. Colorado*, 206 U. S. 46, there has been a material increase in the river depletion by Colorado of the water supply of the Arkansas River, which has been consumed and used by Colorado users for irrigation purposes, and which has diminished the flow of the water into the State of Kansas, and for that reason there have been injuries to

the substantial interests in Kansas. (Finding of Fact Five, page 9.)

(c) That the average annual dependable water supply of the Arkansas River amounted to 1,110,000 acre-feet. (Finding of Fact Sixth, page 10.)

(d) That of the average annual dependable water supply of the basin an award was made of 925,000 acre-feet or five-sixths to the State of Colorado and 185,000 acre-feet or one-sixth to the State of Kansas. (Findings of Fact Eighth and Ninth, pages 10 and 11; Conclusions of Law Two and Three, pages 14 and 15.)

(e) That the water supply allocated to each of the states was to be computed daily, through the use of two index stations, one reflecting the plains runoff and the other the mountain water supply, the water measured at such stations, varying up or down as the two types of water supply in the basin varied, so that the benefits of wet years and the burden of dry years would be borne in the same proportion by the two states. (Master's Finding of Fact Twelve, Conclusions of Law Five, Decree Four.)

III. Specifications of Exceptions to Master's Report to Be Urged Herein

The printed exceptions to the Master's Report filed herein cover 25 pages, the length largely necessitated by reprinting in full the specific findings of the Master with the corrections thereto which form the basis of the majority of the exceptions. We presume that the purpose and intent of Rule 27 (d) will be served by presenting at this point in the brief a summary of the exceptions to be urged herein without reprinting them in full.

Defendants wish to emphasize that the exceptions so filed are not directed to any of the basic Findings or Conclusions of the Special Master. They are rather directed to:

A. The clarification of language used therein, to insure an adequate administrative protection of the apportionment of the water supply awarded by the Special Master to Kansas, and prevent misinterpretations which would lead to disputes and further litigation; and

B. Requesting additional findings of fact, which defendants feel are desirable to be brought to the attention of this court for a more complete understanding of the facts which the Special Master had before him, and upon which the Report of the Special Master has been based.

A summary of the exceptions follows, and page references made are to the pages of the defendants' printed exceptions:

First. The Special Master erred in inadvertently using language which makes it appear that he has found as facts certain physical characteristics of the basin which are contrary to the undisputed evidence.

A. In finding that tributaries to the River contribute measurable quantities which increase gradually from Pueblo to Dodge City, Kansas (Exception 2, page 3).

B. In finding that the general character of the River and valley are practically uniform from where the River emerges from the Rocky Mountains to a point 200 miles east of the western border of Kansas (Exception 1, page 1).

Second. The Special Master erred in failing to make certain additional findings of fact which defendants believe are essential for a complete consideration of the Master's Report. These are as follows:

A. That under natural conditions, and without the aid of irrigation, the per-acre yield in the arid areas of Kansas and Colorado are substantially equal (Exception 4, page 4).

B. That the extent of land which could be irrigated in

Kansas from ditches and laterals heretofore constructed amounts to approximately 414,000 acres, the development of which was rendered impossible by Colorado's water diversion (Exception 6, page 6).

C. Colorado being the upper state has the first opportunity to divert and use the waters of the Arkansas River for irrigation purposes, and has so diverted and used said waters to the extent that the users in Kansas have been deprived of practically all of the dependable flow of the stream. Such water as at present passes the state line into Kansas consists of flash floods of a day or a few days' duration, most of which is not subject to diversion or use. Water which can be captured from such floods is intermittent and bears little or no relation to crop requirements (Exception 7, page 7).

D. That with the construction of the channel reservoir known as Caddoa Reservoir, now completed to the extent of 270,000 acre-feet of capacity and with the ultimate storage capacity of 655,000 acre-feet, the larger portion of the water supply hitherto passing across the state line into Kansas can be captured and conserved in said Caddoa Reservoir (Exception 3, page 3).

Third. The Special Master erred in failing to use clear, concise and unambiguous language in Findings of Fact

8, 9 and 12, his Conclusions of Law 2, 3, 5 and 9, and in the Recommended Decree at paragraphs 1, 2, 4 and 8, which would make impossible misinterpretation of the manifest intent of the Special Master in the equitable distribution of the water supply and its delivery to Kansas in the following particulars:

A. In making the finding that of the average annual dependable supply of 1,110,000 acre-feet, 925,000 should be allocated to Colorado and 185,000 to Kansas, the Master should have likewise designated the percentage of the average annual dependable supply, namely 83.33 percent to Colorado and 16.67 percent to Kansas in order that the ratio of apportionment could be preserved in the distribution of the water supply as it originates. (Exceptions 8, page 8; Exception 9, page 9; Exception 11, page 15; Exception 12, page 16.)

B. That the language of Finding of Fact 9 should be made to conform to paragraph 2 of the proposed Decree in order that the delivery of all of the water allocated to Kansas should be made when and as required by the water officials of the State of Kansas (Exception 9, page 9).

C. That in Finding of Fact 12, Conclusion of Law 5, and paragraph 4 of the Proposed Decree, the Master, in

using two gauging stations as an index for computing the basin water supply as it originates, and thus providing for the apportionment and delivery, should have shown that the water passing such stations represents only a part of the water supply of the basin, and should have clearly set forth the formula through which such determination of total water supply available should be made. He should have stated therein that the recorded flows of water passing such two stations, which serve as an index from which may be computed for the purposes of apportionment of the total water supply of the basin, constitutes fifty-four percent (54%) of the water supply of the basin, and that 30.87 percent of the water passing such stations, which is 16.67 percent of the total basin water supply, shall be the amount which accrues to Kansas as its equitable share, and which is subject to delivery at the state line; thus, insuring a delivery to Kansas of that portion of the water supply found to be Kansas' equitable share (Exception 10, page 11; Exception 13, page 17; Exception 3 to the Proposed Decree, page 22).

IV. ARGUMENT

A. THE PRINCIPLE OF LAW CONTROLLING THIS CASE

The fundamental issue raised by the pleadings in this case is a determination of the equitable apportionment of the waters of the Arkansas River as between the two states. Kansas in its answer for affirmative relief has asked that the court protect and quiet the rights of the State of Kansas to the use of water from the Arkansas River, and that Colorado, its officers, agents and employees, and all residents or citizens of Colorado, shall be perpetually enjoined from diverting water from the Arkansas River or its tributaries to the injury of the rights of the State of Kansas. Colorado in its answer asks that the State of Colorado and its ctizens may be quieted in their diversion, use and employment of the waters of the Arkansas River.

The principle of law upon which the determination of the issues in this case must be based is clear. The pioneer case which declared the principle of law governing the relationship of states to the waters of an interstate stream was *Kansas v. Colorado*, 206 U. S. 46; 27 Sup. Ct. 655. In that case the State of Kansas sought an injunction to re-

strain the State of Colorado, acting directly herself as well as through private persons thereto licensed, from depriving or threatening to deprive the State of Kansas and its inhabitants of all the water theretofore accustomed to flow in the Arkansas River. The State of Colorado claimed complete ownership of all waters arising within the state, and the right to utilize them as it saw fit. In that case the claims of these states were diametrically opposed. As stated by the court:

> "Turning now to the controversy as here presented it is whether Kansas has a right to the continuous flow of the waters of the Arkansas River as that flow existed before any human interference therewith, or Colorado the right to appropriate the waters of that stream so as to prevent that continuous flow . . . If it is diminishing that flow, has it an absolute right to determine for itself the extent to which it will diminish it, even to the entire appropriation of the water?" (206 U. S. at page 85.)

The contentions of both parties were rejected by the court, and for the first time the principle was announced that as between two states on an interstate stream there should be an equitable apportionment of the benefits resulting from the flow of the stream. The case was dismissed without prejudice. The court stated:

> "The decree will also dismiss the bill of the State of Kansas as against all the defendants, without prejudice to the right of the plaintiff to institute new proceedings whenever it shall appear that, through a material increase in the depletion of the waters of the Arkansas by Colorado, its corporations or citizens, the substantial interests of Kansas are being injured to the extent of destroying the equitable apportionment of benefits between the two states resulting from the flow of the river." (206 U. S. at page 117.)

This principle of law was followed in *Wyoming v. Colorado*, 259 U. S. 419; 42 Sup. Ct. 552. There the court for the first time applied the doctrine by prescribing the quantity of water to which the State of Colorado was equitably entitled to use as against the interests of Wyoming. The court there stated, at page 558:

> "The contention of Colorado that she as a state may rightfully divert and use, as she may choose, the waters flowing within her boundaries in this interstate stream, regardless of any prejudice that this may work to others having rights in the stream below her boundary, cannot be maintained. The river throughout its course in both states is but a single stream, wherein each state has an interest which should be respected by the other."

The same principle was applied in the case of *Connecticut v. Massachusetts*, 282 U. S. 660; 51 Sup. Ct. 286.

Following this, in the case of *State of New Jersey v. State of New York*, 283 U. S. 336; 51 Sup. Ct. 478, at page 479, the court said:

> "Different considerations come in when we are dealing with independent sovereigns having to regard the welfare of the whole population and when the alternative to settlement is war. In a less degree, perhaps, the same is true of the quasi-sovereignties bound together in the Union. A river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it. New York has the physical power to cut off all the water within its jurisdiction. But clearly the exercise of such a power to the destruction of the interest of lower states could not be tolerated. And on the other hand equally little could New Jersey be permitted to require New York to give up its power altogether in order that the river might come down to it undiminished. Both States have real and substantial interests in the River that must be reconciled as best they may. The different traditions and practices in different parts of the country may lead to varying results but the effort always is to secure an equitable apportionment without quibbling over formulas."

One of the late cases where this same principle was referred to and applied is the case of *Hinderlider v. La Plata River and Cherry Creek Ditch Company*, 304.

U. S. 92; 58 Sup. Ct. 803, at page 807 of which the court states:

> "First. As the La Plata River flows from Colorado into New Mexico and in each state the water is used beneficially, *it must be equitably apportioned between the two.*"

It will be noted that in the development and application of the doctrine as first announced, equitable apportionment of the benefits has been more definitely defined by the Supreme Court in its later cases as an equitable apportionment of the water.

The equitable division of the water supply of the Arkansas River between Kansas and Colorado here is before this court for the first time.

Because there is little room for argument as to the law of the case, it is apparent that the cause before the court is one of equity based upon a consideration of facts.

Under these declarations of law two problems are presented to the court for final determination—First, to adjudicate to each state that portion of the water supply to which it may be equitably entitled, and with respect to which each state may in its sovereign capacity obtain the full benefit thereof; and second, it is for the court to define the rights of each state with respect to the use of water with such definiteness that adequate administra-

tion of the water supply can be had, and adequate protection afforded to insure a delivery to the lower state (Kansas) of its adjudicated share without infringement of that amount by upper state users.

Defendants wish to again emphasize that as to the determination of the fundamental issues of this case made by the Special Master we have no complaint, nor are defendants' exceptions directed thereto. The Master has found that since the taking of testimony in the case of *Kansas v. Colorado*, 206 U. S. 46, a material increase in the River depletion by Colorado of the water supply of the Arkansas River, which has been consumed and used by Colorado users for irrigation purposes, has diminished the flow of the water into the State of Kansas, and that by reason thereof there has been injury to the substantial interests of Kansas (Master's Report, Finding 5, page 9). This was adequately supported by evidence of comparison of years of similar water supply (Kansas Exh. 62, page 1519; Kansas Exh. 70, page 1569), and evidence that since the close of testimony in the original Kansas-Colorado suit consumption of water in Colorado has increased to the extent of 300,000 acre-feet of the average yearly dependable water supply (R. 1742), and that the Colorado average consumption

during the 11 years, 1920 to 1930 was approximately 95 percent of the dependable supply (R. 1521). The Master likewise found that the average annual dependable, and fairly continuous, water supply of the Arkansas River and its tributaries is 1,110,000 acre-feet (Master's Report, Finding of Fact 6, page 10). This was amply shown by the only complete water supply record in evidence (R. 1442 to 1519; Kansas Exhs. 18 to 62 inclusive).

The Master likewise, from a consideration of all the evidence, determined the fair and equitable apportionment of the water supply of the basin, allocating to the State of Colorado 925,000 acre-feet and to the State of Kansas 185,000 acre-feet of the average annual dependable water supply (Master's Report, Findings 8 and 9, pages 10 and 11; Conclusions of Law 2 and 3, pages 14 and 15; Recommended Decree 1 and 2, pages 19 and 20). This amounts to an apportionment of one-sixth to Kansas and five-sixths to Colorado.

Defendants here suggest that the 185,000 acre-feet allocated by the Special Master to Kansas is a considerable decrease from the average of 260,000 acre-feet which Colorado's Exhibit 209, page 6640, shows was the average annual amount which passed across the state line into Kansas during the period 1908 to 1938. Because of this

fact defendants are reluctant to accept this small apportionment. Defendants have not excepted to this apportionment because it appeared that the manifest intent of the Special Master's Report and proposed decree was to provide a delivery of the same in accordance with irrigation needs, and upon the demands of Kansas state water officials, thus converting a larger gross unusable supply into a lesser quantity of usable irrigation water. We here again suggest that the exceptions directed to the Master's Report are confined either to clarification of language, which clearly protects the delivery of the small portion allocated to Kansas, so that it will be available in conformity with irrigation needs, or to requests for additional findings of fact from evidence which the Master clearly accepted, but which he did not reduce to express findings, and which defendants believe are essential to an understanding by this court of the absolute necessity for proper delivery and adequate protection of the small quantity of water apportioned to Kansas.

B. THE ARID AREA IN KANSAS IS SOLELY DEPENDENT UPON THE WATER SUPPLY FROM COLORADO FOR THE PRACTICE OF IRRIGATION

(Relating to Exceptions 1 and 2)

The basis for the foregoing statement is found in the physical characteristics of the River Basin in Colorado and Western Kansas. We are dealing here with an arid region. Where the rainfall is below 20 inches, that area is arid. Below 20 inches of rainfall must be supplemented to carry on agriculture in a satisfactory manner. (R. 2263.) With respect to a line of demarcation, west of which irrigation should be practiced, in irrigation literature the line has frequently been set at the 100th meridian which passes through Dodge City, or at the line of 20 inches of rainfall on the great plains (R. 1416).

In the Arkansas River basin to the west in the mountainous area in Colorado annual precipitation runs above 20 inches. This is reflected by mountain recording stations where the average annual rainfall is, such as Lake Moraine, 24.70 inches—47 year record; La Veta Pass, 22.29 inches—33 year record; and North Lake, 22.74 inches—45 year record. To the east of Dodge City in Kansas precipitation runs from 20 inches to something more than 30 inches. Thus, there is an area of precipita-

tion below the 20-inch rainfall belt lying generally east of the mountains in Colorado and west of a line drawn north and south through Dodge City.

This region in the two states under scrutiny lies in the arid region of the United States, part in Kansas and part in Colorado. It has been so classified by the United States government in its classification of land areas in the United States (R. 372). In this arid area rainfall deficiency makes irrigation necessary for the production of certain crops, and necessary for the securing of satisfactory yields of any crop (R. 2262). For this reason it is important that the fact be made clear that the Kansas arid region has no substantial source of water for irrigation purposes other than that flowing into Kansas from Colorado. The record clearly shows that in the 200 mile stretch of River from the Kansas-Colorado line eastward to approximately Larned there are no entering tributaries except for a few small dry arroyas (Colorado Exh. 6, R. page 35). From the Kansas-Colorado line east to Kinsley, Kansas, there are no tributaries which might supplement the stream flow in the Arkansas River whatever (R. 2268). Kinsley is located approximately 160 miles east of the state line and approximately 200 miles east by river channel. There are no live tributaries entering the stream until Larned.

Kansas, is reached (R. 1495). Larned is located approximately 190 miles east of the Kansas-Colorado line and 230 miles east by river channel (R. 1495). These facts are uncontroverted in the record.

While the Master has found as a fact, in the last paragraph of the Second Finding of Fact, that "The lands in Kansas attempting to practice irrigation are dependent upon the flow of the Arkansas River which comes into Kansas from Colorado," the previous sentence, "The general characteristics of the River and valley and country adjoining are practically uniform from the point where the River emerges from the Rocky mountains to a point about 200 miles east of the western border of Kansas," is misleading, as it inferentially would indicate that the large number of tributaries which enter the River from both sides in Colorado (Colorado Exh. 6, R. p. 35) likewise exist in the arid region in Kansas, a fact contrary to the record. In order to clarify this situation defendants' first exception, page 1, requests that the words "except that in that portion of the River and valley lying in Kansas there are no entering tributaries except for a few small dry arroyas" be inserted after the last quoted portion of the paragraph, for the sake of a clear understanding of the facts.

To the same effect is defendants' Exception II, page 2, to the first paragraph of the Third Finding of Fact. The Master there states, "The tributaries to the River contribute water in measurable quantities, which is due to rainfall, surface runoff, and seepage return water from irrigation, and in some instances from melting snows in the mountains, and gradually increases from Pueblo, Colorado, to Dodge City, Kansas." Since there are no tributaries in Kansas from the state line to Dodge City (Larned, where the first tributary enters, is located considerably to the east), there can be no contribution of water from any tributary source whatever, and a deletion of the ambiguous phrase "and which increases gradually from Pueblo, Colorado, to Dodge City, Kansas" is essential for a correct understanding of the true situation.

C. RELATIVE NEED FOR WATER IN CROP PRODUCTION IN THE TWO STATES

(*Relating to Exception 4*)

A primary factor for consideration in determining equitable apportionment is an understanding of the need for supplemental water in crop production in the arid area of Kansas and Colorado. This is induced by the allegation made by Colorado in its reply, "The land situated in the Arkansas River drainage basin within

the State of Colorado is dry, barren and unproductive in its natural state." This allegation is entirely disproved by the undisputed evidence to the effect that per-acre yields under natural conditions or dry farming in the two comparative areas are on a substantial parity.

There is a tendency to base judgment respecting the need for water purely upon the difference in average annual precipitation, wrongfully assuming that a lesser precipitation in one area indicates a greater need for water for crop production than in an area where precipitation is somewhat higher. This, however, is utterly unsound, since it fails to take into consideration other factors, such as daily and monthly distribution of rainfall in conformity to plant growth needs, the effect of higher temperatures and greater wind velocities, which operate to substantially affect the utility of rainfall for plant growth because of evaporation, and the character of soil which may or may not protect precipitation from the effects of evaporation. All are factors that must be studied, and in the final analysis answered by the actual results of crop production disclosed by the yields per acre under natural conditions in the two arid areas under consideration.

The Master in his report (Finding of Fact Third, page 7), in the third paragraph, found:

> "Precipitation, melting snows, temperature, evaporation and wind velocity, and the character of the soil appear to be factors which are interrelated in crop production and of sources of water supply of the Arkansas River, . . . The mean average annual temperature in the Colorado area ranges from two to five degrees lower than in Kansas area and in Western Kansas the wind velocities are higher than in the eastern region in Colorado, which has an effect upon evaporation. The soils in both Colorado and Kansas areas are well suited to irrigation, but the character of the soil in Kansas area, which contains more silt than in the Colorado area, will hold larger quantities of water without loss by deep percolation."

The Master's Report, however, is silent on the comparative crop yields per acre resulting from these interrelated climatic factors which he has referred to. Since resultant yields are necessary for an understanding by this court of the true picture of crop production under natural conditions, the defendants have requested, in Exception Four at page five, that the following fact be added to the last quoted portion of the Master's Report:

> "The fractionally greater monthly precipitation in the Kansas area is largely dissipated by the greater evaporation, so that the beneficial effect of precipitation on plant growth in both areas is sub-

stantially equal. The result is that crops under natural conditions without the aid of irrigation produce substantially the same yields per acre in eastern Colorado as in western Kansas."

This requested finding of fact is supported by undisputed evidence obtained through comparison of crop yields in the arid regions of both states. Crops are not grown with average rainfall. (R. 2261.) The amounts of the yields of various crops, or the ability to raise them at all, depends entirely upon the soil moisture available during the growing season in the particular year in which the crop is grown. For this reason monthly and even more important daily precipitation is the only basis for the determination of the relationship of precipitation to agriculture (R. 2273).

Although the difference in monthly precipitation is only a fraction of an inch per month in favor of the Kansas area (Kansas Exh. 12, page 1414), other factors enter into the picture, such as condition of the soil at the time of rainfall, the rate of evaporation, temperatures, and wind velocities, all of which play an important part in reducing the values to plant growth of the actual precipitation (R. 2274). The two percent to five percent higher temperatures and the higher wind velocities in the Kan-

sas area, as found by the Master, vitally affect plant growth. Wind velocity and temperature go to bring about evaporation (R. 2287). Higher wind velocities and higher temperatures make for relatively higher evaporation. Evaporation subtracts from precipitation an amount of moisture which is lost to plant growth.

The effect of all of the foregoing factors operating together is found in a study of the actual yield per acre of similar crops grown under natural conditions without irrigation.

Comparisons show that in crop production under natural conditions the two areas, Eastern Colorado and Western Kansas, are substantially on a parity. A comparison of crop yields in two comparable areas in Kansas and Colorado, where agriculture is practiced under natural conditions, that is, mere cultivation of the soil without the aid of any supplemental water supply, has been made. Kansas Exhibits 102, 103 and 104, pages 2294 and 2295, present such a comparison.

In making this comparison similar areas were selected in both states, reaching east of the state line 102 miles, and west of the state line 108 miles, containing 10,890 square miles in Kansas and 11,350 square miles in Colorado, all symmetrically located along the Arkansas River

as an east and west axis (R. 2291; Kansas Exh. 102, page 2294.)

By comparing a tier of counties north of the River and south of the River in Kansas with a corresponding tier of counties in Colorado, and excluding the tier of riparian counties along the River so that no benefits from irrigation are reflected, the actual yield per acre of crops grown under natural conditions speaks for itself. Production in those areas is the result of dry farming enterprise alone.

Comparison of crop yields in these groups over the period 1921 to 1930 for which comparable records are available show that crops raised in this arid region in Kansas and Colorado without benefit of irrigation are strikingly similar (R. 2299; Kansas Exhs. 103 and 104, page 2295). The main crops grown in these two areas are winter wheat, corn, oats, barley, rye, grain sorghums, and broom corn. In the comparison made identical crops were considered for both areas, and in the counties lying north of the river in Kansas constituted 95.5 percent of the total crop acreage, and in Colorado 95.3 percent of the total crop acreage. In the tier of counties south of the River the crops studied constituted in Kansas 98.7 percent of the total in crops, and in Colorado 97.8 percent.

A comparison in yields in bushels per acre in the two

areas over the 10-year period 1921 to 1930 indicates that production under natural conditions was substantially the same (R. 2313-18). Statistics for the same period with respect to two of the Colorado counties lying nearest the mountains, where the average annual rainfall was only between 11 and 12 inches indicated the same identical situation. For the sake of brevity we submit a summary of the comparisons heretofore referred to:

Area	*Average Annual Rainfall, inches*	*Crops* — *Winter Wheat*	*Corn*	*Oats*	*Barley*
		Yields per Acre in Bushels			
Kansas:					
North of River Tier.....	15½ to 19	8.74	13.70	15.2	15.36
South of River Tier.....	15½ to 19	10.6	15.58	14.95	14.06
Colorado:					
El Paso County	11.23	13.1	14	19.1	15.6
Pueblo County	11.98	9.9	12.6	14	13.4
North of River Tier.....	13 to 15	8.65	13.60	14.95	13
South of River Tier.....	13 to 15	8.1	11.9	12.5	11.80

The fact that the area devoted to dry farming in Colorado is less than that in Western Kansas is easily accounted for by two main factors: First, the westward course of land settlement, and development of Western Kansas, before Eastern Colorado; and, Second, the emphasis placed on irrigation in the Colorado area because as long as a primary diversion opportunity existed, and water could still be captured, the higher rewards and returns incident thereto did not force development of a dry farming

area, until the usable water supply had been completely depleted. The opportunities, however, for such dry land farming development are shown by Kansas Exhibit 105, which indicates that land available for dry farming in 1929, was in: Baca County, Colorado, 968,045 acres suitable for dry land agriculture, with 252,485 in crops; Cheyenne County, Colorado, 845,820 acres suitable for dry land agriculture, with 107,050 in crops; and Kiowa County, Colorado, 746,389 acres suitable for dry land agriculture, with 83,770 in crops. The crop acreage in these three counties had increased since 1921 by 89,093.

Kansas Exhibit 109 shows with respect to the four crops of winter wheat, corn, oats, and barley, that in 1930: Elbert County with dry farming land amounting to 352,362 acres has 95,670 acres in these four crops; El Paso County with 217,010 acres had 63,820 acres in these four crops; and Lincoln County with 909,372 acres of dry farming land had 154,650 acres in these four crops. In the 13 counties east of the mountains lying in or partly in the Arkansas River basin there were 777,890 acres in 1929 devoted to dry land agriculture of the four crops above named. The acreage in grain sorghums amounted to 164,790 acres (R. 1862). This would raise the foregoing total to 942,680 acres. Broom corn is not

reflected in these figures for lack of statistical information, although it is one of the very best crops adapted to dry land agriculture, and we can assume that if the broom corn statistics were available the actual acreage producing dry farm crops in the 13 counties might well run over 1,000,000 acres.

We suggest that when yields are shown to be substantially the same in this arid region, whether located in Kansas or Colorado, it is certainly demonstrated that the equity of need for a supplemental water supply in the two areas, when balanced, one against the other, is substantially equal in both states. It is not maintained that these comparisons indicate that dry land farming in either area can be classified on the basis of successful agriculture, but they do demonstrate an equality of handicap, and that the need for a distribution of the benefits of a supplemental water supply from the Arkansas River is substantially the same. In the light of the foregoing facts the allegation of the State of Colorado in its reply at page 41, that, the land situated in the Arkansas River drainage basin in Colorado is dry, barren, and unproductive in its natural state, is without foundation in fact. In the face of the record the testimony of State Engineer Hinderlider for Colorado, that irrigation is an absolute

necessity where precipitation is below 15 inches (R. 152), has been disproved by Colorado farmers. When Witness Patterson for Colorado was asked this question: In Eastern Colorado along the Arkansas River would it be possible to raise crops without the existence of these irrigation systems and application of water to the land? His answer was, "No it would not." (R. 421.) He further testified that the line of irrigation is the east line of Colorado and the west line of Kansas (R. 421), and that rainfall does not directly contribute to the raising of crops along the Arkansas River in Colorado (R. 423). Such testimony in the face of 1,000,000 crop acres producing per acre yields substantially the same as Western Kansas needs no further comment.

In concluding this portion of the brief we venture to suggest that the observations of the Supreme Court of the United States in the Kansas-Colorado case in 1901, namely, "and it would seem almost certain that reliance upon mere cultivation of the soil would not have anything like the effect in Colorado that it has had in Kansas, and that barrenness which characterized portions of this territory of Colorado would have continued for an indefinite time unless relieved by irrigation," has been shown by subsequent agricultural development to be erroneous.

D. DEVELOPMENT OF KANSAS IRRIGATION OPPORTUNITIES RENDERED IMPOSSIBLE BY COLORADO USE

(Relating to Exception 6)

Although the Special Master in Finding Fourth at page 8 has stated:

> "Both states from their beginning have recognized the need of water for irrigation and the using for that purpose of the public waters in their states."

and again in Finding Nine at page 11 has stated:

> "The irrigated acreage in the State of Kansas of the water supply of the Arkansas River and its tributaries is 65,028 . . ."

the report is silent as to the extent of the acreage under constructed irrigation projects in Kansas, which could have been developed but for Colorado water depletion. Because of this defendants have requested the following additional finding:

> "That the extent of land which could be irrigated in Kansas from ditches and laterals heretofore constructed, amounts to approximately 414,000 acres, the development of which was rendered impossible by Colorado's water diversions." (Exception 6, page 7.)

When there is under investigation two areas where both are dependent upon a limited water supply, in which

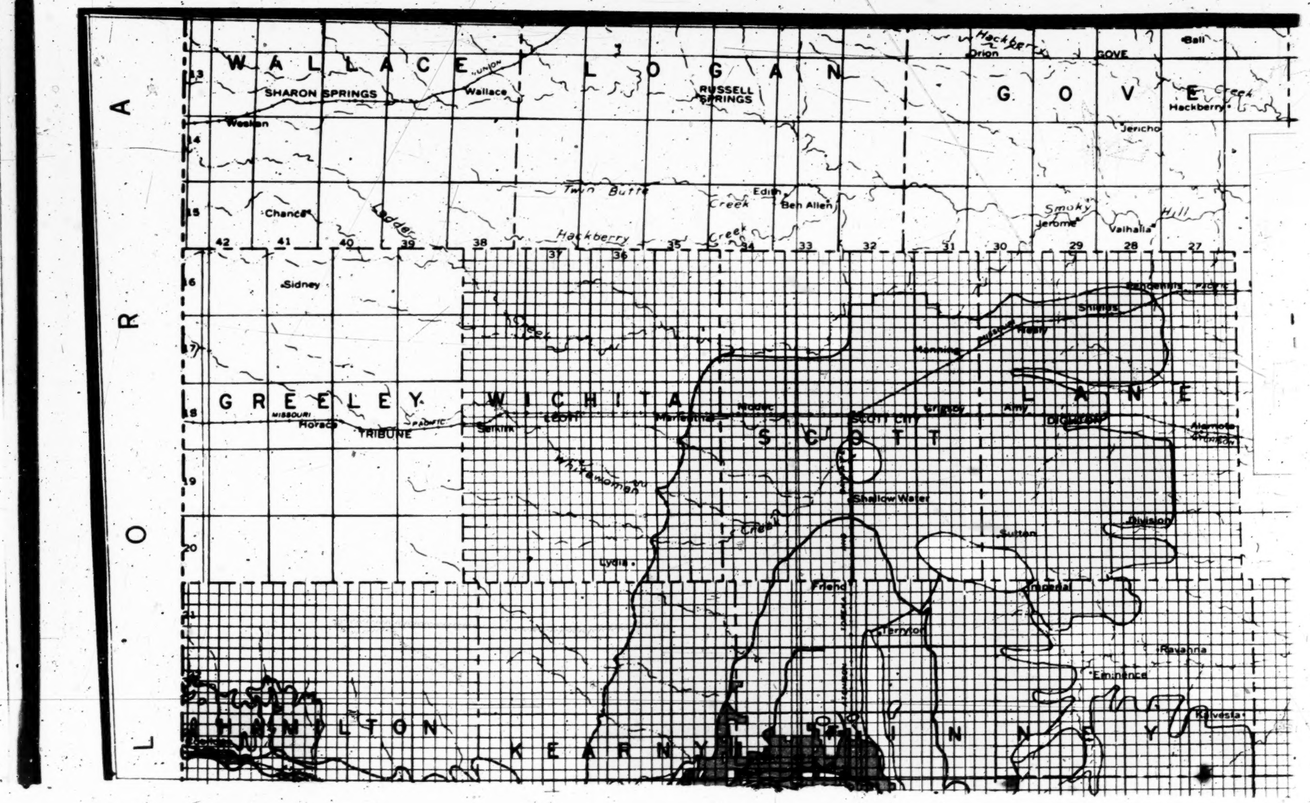
the upper area—in this case, Colorado—has a primary opportunity and an unrestricted exercise of that opportunity, and where the lower state—in this case, Kansas—is left with only a residual opportunity to make use of such water as escapes from the upper state unused, the extent of development forms no true basis for weighting equities. The reason for this is that, although in the beginning the opportunity for development may have been equal, every exercise of the opportunity by the upper state and every increase in development by the upper state correspondingly subtracts from the opportunity of the lower state to develop.

Prior to the year 1884 the following more important ditches, or their predecessors with respect to water rights, were commenced in the plains region in Colorado: The Rocky Ford, the Jones, the Catlin, the Rocky Ford Highline, the Oxford Farmers, the Bessemer, the Kessee, and the Lamar. The quantity of water allocated to these ditches as of that time represented a total of only 331.46 second feet (Kansas Exh. 92). This represented only a very small amount of the more than 6,000 second feet subsequently decreed to these and other major ditches in these same districts in Colorado.

On the other hand, in Kansas prior to 1884 the Garden

City Ditch, the Farmers Ditch belonging at present to The Finney County Waters Users' Association, the Great Eastern, and the South Side Ditch, were put into operation and water applied to beneficial use for irrigation purposes. Thus, with respect to the early efforts to apply water to beneficial use for irrigation by these ditches it can hardly be said that use to the full extent of the decrees of the Colorado ditches prior to 1884 would form any substantial diminution in the water supply available for Kansas use.

Not only was there a recognized need for water in the area in Western Kansas running 130 miles east of the Colorado line, but ample land was available for its practice. This land was ideally situated for the practice of irrigation by direct diversion from the one source of supply for such purpose, the Arkansas River. Kansas Exhibit 110, which is hereto attached, is a map showing the lands in Western Kansas lying north of the River which are at present irrigable, lands which were or could have been irrigated from ditches and laterals which were built. The extent of the land which could have been irrigated from the ditches and laterals referred to above, which were built, amounted to 414,000 acres, a development which undoubtedly could and would have taken place ex-



KANS. EX. 110

MAP OF ARKANSAS RIVER BASIN IN WESTERN KANSAS

SHOWING

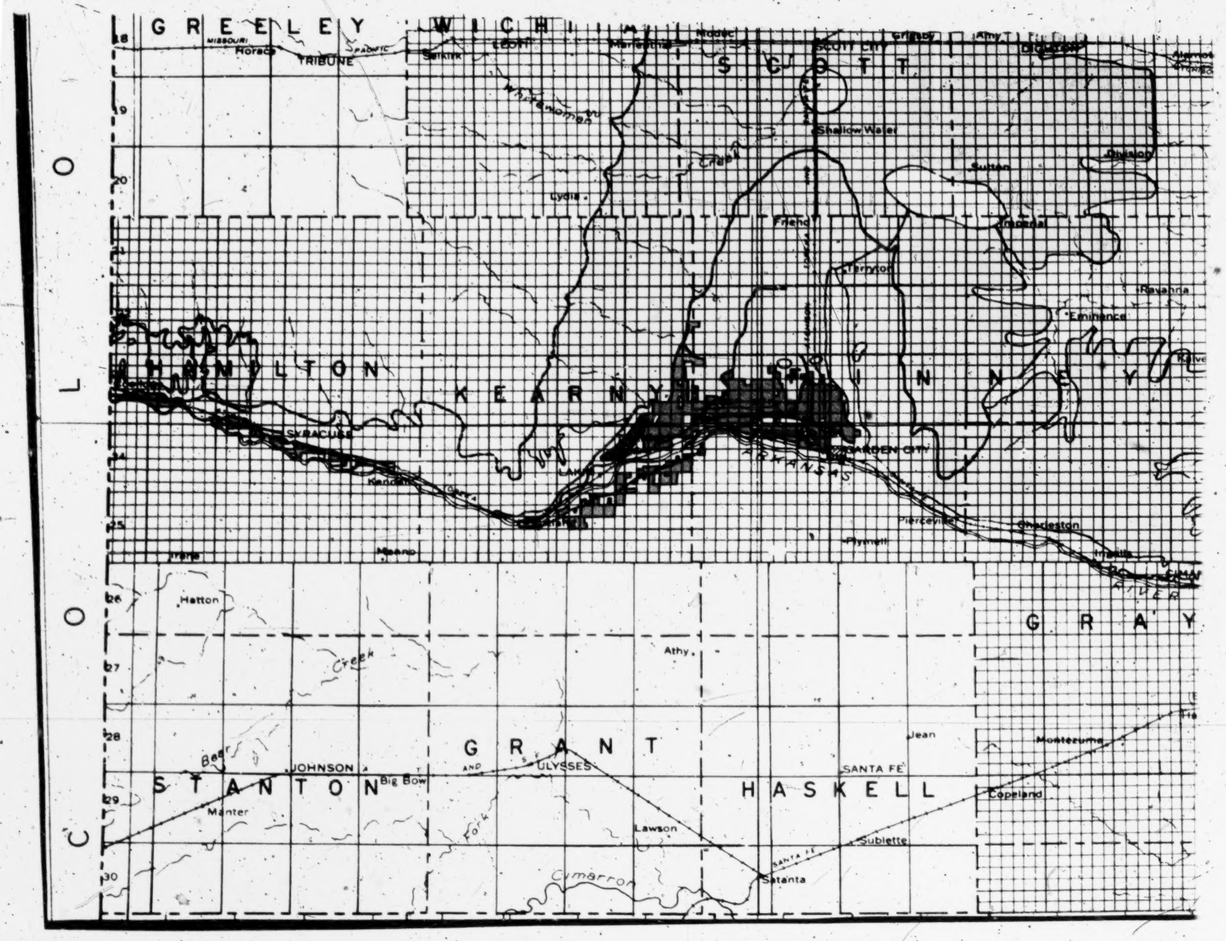
IRRIGATED LANDS-ABANDONED PROJECTS-IRRIGABLE LANDS

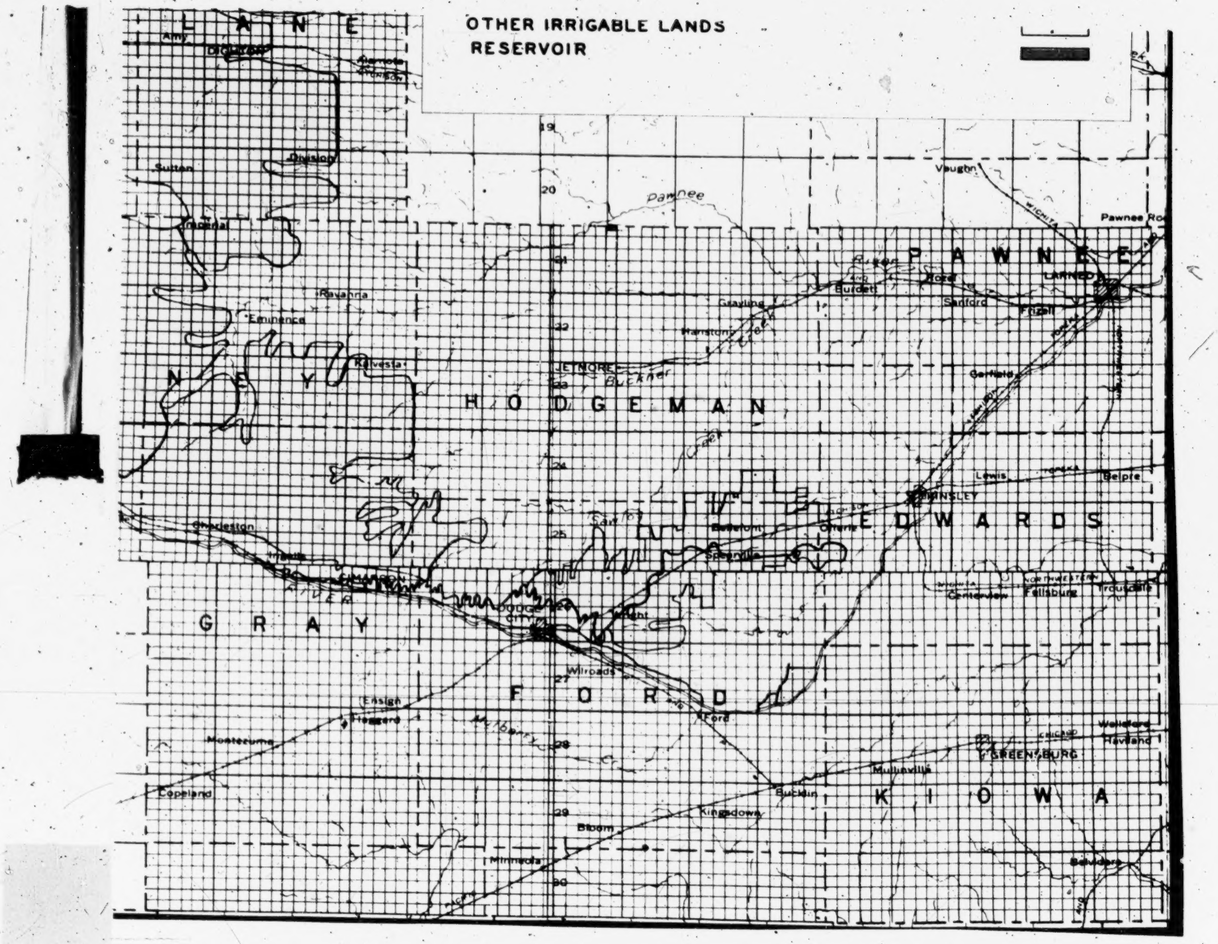
LAND IRRIGATED DURING 1931

IRRIGABLE LANDS UNDER ABANDONED DITCHES

OTHER IRRIGABLE LANDS

RESERVOIR


GREELEY
WICHITA
SCOTT
HAMILTON
KEARNY
FINNEY
GRAY
STANTON
GRANT
HASKELL
COLORADO
Tribune
Horace
Scott City
Shallow Water
Lydia
Friend
Plymell
Eminence
Ravanna
Syracuse
Kendall
Garfield
Hartland
Hatton
Athy
Johnson
Big Bow
Ulysses
Santa Fe
Manter
Lawson
Sublette
Satanta
Cimarron
Beer Creek
Jean
Montezuma
Coppeland


OTHER IRRIGABLE LANDS
RESERVOIR
LANE
PAWNEE
HODGEMAN
EDWARDS
GRAY
FORD
KIOWA
Pawnee Rock
Larned
Sanford
Garfield
Belpre
Lewis
Kinsley
Offerle
Fellsburg
Dodge City
Wright
Ensign
Kingsdown
Bucklin
Mullinville
Greensburg
Haviland
Minneola
Bloom
Coppeland
Montezuma
Jetmore
Hanston
Gravelin
Burdett
Vaughn
Pawnee

cept for Colorado diversions. This exhibit shows in addition in the area north of the River alone approximately 1,000,000 acres which could have been reached by ditches and laterals north of the River, with probably an equal amount of desirable land lying south of the River (R. 2339).

We thus find in this early period development going forward in the plains area of both states. In Colorado, although water rights were adjudicated in different districts, protection of the earlier users was afforded by state administration, and the taking of water from the stream controlled in the order of the priority date.

The protection which the Colorado administration afforded lower water users with early decrees against upper water users with later decrees stopped at the state line. The early development in Kansas, although substantially the same in time and occurring before any substantial acreage was placed under irrigation in Colorado, was left without any protection to their earlier application of water to beneficial use. With ever increasing water consumption by the upper state senior priorities in a lower state find the dependable water supply gradually lessened until practically exhausted by junior priorities in an upper state (R. 1366).

E. EXTENT OF WATER DEPLETION BY COLORADO AND CHARACTER OF WATER SUPPLY REMAINING

(Relating to Exception 7)

Although the Special Master made the following finding (Finding 5 at page 9):

> *"Depletion by Colorado Of The Water Supply Of The Arkansas River Since The Taking of Testimony In The Case of Kansas Against Colorado Decided in 1907.* There has been since the taking of testimony in the case of Kansas against Colorado cited in 206 U. S. 46, in 1907, a material increase in the river depletion by Colorado of the water supply of the Arkansas River, which has been consumed and used by Colorado users for irrigation purposes and which has diminished the flow of the water into the State of Kansas and that by reason thereof there has been injuries to the substantial interests in Kansas."

a complete understanding of the existing situation, and of the absolute necessity of protecting the delivery of Kansas' portion of the water supply in conformity with crop requirements compels a more detailed examination of the facts. For this reason defendants have requested an additional finding of fact as follows:

> "Colorado, being the upper state, has the first opportunity to divert and use the waters of the Arkansas River for irrigation purposes, and has so

diverted and used said waters to the extent that users in Kansas have been deprived of practically all of the dependable flow of the stream. Such water as at present passes across the state line into Kansas consists of flash floods of a day or a few days duration, most of which is not subject to diversion or use. Water which can be captured from such floods is intermittent and bears little or no relation to crop requirements."

The development of irrigation in Colorado extended over a period of 50 or 60 years. The impact of each succeeding year's development, whether small or great, placed an additional burden on the water supply and depleted the supply to the extent of such burden. The allocation of this burden to any particular period of time, and whether temporary or permanent, is a complex problem. This is due to the fact that, first, the type of burden placed upon stream flow has a different resulting effect on depletion; and second, the difference in the total quantity of the water supply each year requires comparison of years when the water supply was similar in quantity in order to obtain an accurate determination of the extent of the depletion.

The simplest, and perhaps the most accurate, method of determining the extent of permanent depletion is by the ascertainment at any given period of time of the acreage

under irrigation which constitutes a permanent burden upon stream flow.

1. Temporary and Permanent Depletion

When land is first put under irrigation more water is applied to the land than is permanently consumed. This is largely due to the fact that in new areas a building up of the water table takes place. As the water table is built up, there is created a return flow back to the stream over a period of months or a few years, depending upon the distance of the irrigated lands from the stream, the character of the soil, and the topography. However, this, while lost to the stream in the form of diversions, is not a permanent loss, as it ultimately gets back to the stream in the form of return flow. This might be likened to a case of priming the pump. The excess water which is not destroyed is in reality borrowed from the stream in the early stages of irrigation, and finds its way back for other uses after the period of stabilization has been reached. Of course this amount which is borrowed and not permanently destroyed might fluctuate somewhat between dry cycles and wet cycles, but from the beginning the actual amount of water which is permanently lost to the stream has a fairly constant consumptive use value

per acre (R. 5201). Witness Knapp said, "It is my opinion that the permanent depletion of the average water supply depends upon the actual number of acres irrigated and the date when they were placed under irrigation."

Every acre of land which is put under irrigation has a very definite ultimate consumptive use of water. The water is consumed in plant growth, and is evaporated in connection with the growing of crops. This water is thus totally destroyed or consumed, and to that extent is a complete depletion of the water so used. From the particular time that a given acre is put under irrigation it becomes as of that time a permanent additional burden upon the water supply of the stream. Before that acre was put under irrigation that amount of water was not consumed in plant growth or destroyed by evaporation incident to cultivation (R. 5199-5200).

2. Irrigated Acreage as Measure of Permanent Depletion

The actual irrigated acreage forms the only means by which the extent of permanent depletion can be measured. Although the irrigating ditches in the great irrigated area in Colorado, east of Pueblo, were first started during the 1870's, only 33,390 acres were under irrigation in 1889. This had increased to 143,952 acres in 1899, 212,341 acres

in 1902 and to 389,435 acres in 1929. Thus the Kansas ditches which had been constructed and were in operation 1889, at a time the Colorado ditches in the plains area were irrigating only approximately 33,390 acres, have been faced with the permanent depletion of the water supply of the Arkansas River to the extent of the burden of 356,045 additional acres of additional land under irrigation in Colorado since the time the Kansas ditches first applied water to beneficial use.

If one takes the basis of the irrigation census of 1902, the total acreage under irrigation increased from 300,115 in 1902 to 558,072 in 1929 (Kansas Exh. 52, page 1507). In this period the State of Kansas has faced a permanent depletion of water supply since that date, by reason of the burden of 257,957 acres of land placed under irrigation in Colorado; or if we take the extent of the depletion in the five great irrigating counties in Districts 14, 17 and 67 where the irrigated acreage increased between 1902 and 1929 from 212,341 acres to 389,435 acres, the extent of the permanent depletion of the water supply is measured by the 177,094 acres of additional burden imposed upon the stream flow in that period and by that area.

To visualize this increased acreage in terms of the ex-

tent of actual water depletion it is only necessary to apply thereto a measure of the stabilized consumptive use of water per acre. Witness Tipton for Colorado stated that he did not believe consumptive use under stabilized conditions would be above 1.90 acre-feet per acre (R. 4372). He likewise arrived at an average consumptive use figure for the five-year period 1926 to 1930 of 1.96 acre-feet per acre. This period, being at least a decade after any substantial ditch or reservoir development had taken place, might also well reflect the measure of permanent stabilized consumptive use in Colorado. By taking the value 1.9 as the measure of permanent stabilized consumption, and applying it to the acreage under irrigation at any one given time, it is possible to determine with reasonable accuracy the extent of the permanent depletion of the water supply at such time. Thus, on the basis of 33,390 acres irrigated in 1889 in the basin between Pueblo and the Kansas-Colorado line, the extent of the burden of water depletion in that area and at that time would amount to 33,390 acres times 1.9, or 63,440 acre-feet. The effect of this on an average dependable water supply of 1,110,000 acre-feet would hardly represent an effective obstacle to irrigation development in Kansas.

If we take the same area, that is, from Pueblo to the Kansas-Colorado line, as of the period of 1902, we find the total irrigated acreage of 212,341 acres. By applying the same formula the extent of permanent depletion of water supply due to irrigation in that area amounted to approximately 403,420 acre-feet. This represented a rather substantial amount and by that date was making effect felt on the Kansas ditches. However, by 1929 the permanent water depletion resulting from the irrigation of 389,435 acres in this same area, Pueblo to the state line, had brought about a depletion amounting to 739,926 acre-feet, or an added burden between 1902 and 1929 in that area alone amounting to 336,506 acre-feet. We have used this particular section since the great increase in irrigated acreage occurred in that particular region, and since irrigation in that area and irrigation in Western Kansas started at substantially the same time. However, if we take the irrigated acreage in the entire Arkansas River basin as of 1902, when 300,115 acres were listed as being under irrigation, the permanent burden upon the water supply at that time amounted to approximately 570,218 acre-feet.

By 1929 the total irrigated acreage amounting to 557,-148 acres had imposed a permanent depletion on stream

flow amounting to 1,058,581. The foregoing figures with respect to acreage were obtained from (Kansas Exhibit 52, R. p. 1507).

3. Reservoir Development as an Additional Factor

It must be remembered that the permanent depletion by this acreage does not take into consideration any depletion by reason of loss in water storage. As before stated, the storage of water in reservoirs in the Arkansas basin in Colorado started approximately in 1896. By 1902 five reservoirs had been constructed with a total decreed capacity of 217,925 acre-feet. Subsequent to that time, and continuing down until approximately the year 1920, 28 additional reservoirs were constructed in Colorado with a total decreed capacity of 321,226 acre-feet, or a total storage capacity of 539,151 acre-feet. At the present time, however, the total storage capacity, omitting the new Caddoa Reservoir, amounts to 521,506 acre-feet due to the washing out of two of the reservoirs (Kansas Exhs. 65 and 67; pages 1543 and 1556).

The reservoir development in Colorado and the storage of large quantities of water therein adds an additional factor of permanent depletion. Mountain and plains run-off is stored in large quantities and used in late summer

irrigation, or carried off in years of heavy runoff and used in years of low runoff. The water impounded in these reservoirs is largely lost to stream flow outside the State of Colorado (R. 1525). The effect of these reservoirs on the permanent depletion of water supply comes about to a considerable extent through evaporation of water during the period in which it is held in storage for future use. Evaporation losses of water stored in reservoirs in the plains area are heavy in the summer months, and are a total loss to irrigators in Colorado and Kansas (R. 1525). In the plains area in Colorado the rate of evaporation during the summer season amounts to 2.75 feet in depth, while the annual rate is 3.62 feet in depth (Colorado Exh. 219, page 6689), so that in this particular section stored water sustains a loss by evaporation of 3.62 acre-feet per acre of water surface in the reservoirs annually.

Inasmuch as the amount of water in storage on November 1 in the Arkansas River basin in Colorado, after summer uses were satisfied, averages 112,000 acre-feet for the 18 years of which records were available (R. 1555), it is evident that depletion by evaporation becomes an item of considerable importance.

These two factors of increased irrigated acreage and

increased water storage have resulted in increased water consumption in Colorado. The Record shows from the testimony of Witness Meeker (R. 1565) that the increased consumption in the entire river basin in Colorado is as follows:

1870 estimated at	45,000 acre-feet
1880 estimated at	100,000 acre-feet
1890 computed at	280,000 acre-feet
1898 to 1902	630,000 acre-feet
1903 to 1907	760,000 acre-feet
1908 to 1912	920,000 acre-feet
1913 to 1917	1,100,000 acre-feet
1918 to 1922	1,070,000 acre-feet
1923 to 1927	1,020,000 acre-feet
1928 to 1930	1,060,000 acre-feet

Because water supply fluctuates from season to season, and changes from wet period to dry period, an analysis through comparison of years of similar water production is the only practicable method of ascertaining a true picture of the progressive diminution of state line outflow. Years of similar water supply in an early period and later period can be compared. It is almost impossible to grasp the relationship of the various years and their bearing upon the water supply problem until they are portrayed graphically for the purposes of comparison (R. 1569).

4. Progressive Character of Depletion

We here attach Kansas Exhibit 70. By arranging years of similar water supply in the manner shown in this exhibit one is enabled to draw the actual comparisons and study the problem as a whole without becoming involved in making comparison of figures themselves (R. 1569). In Graph B shown on Exhibit 70 the years of water supply are arranged according to the magnitude of flow. This arrangement is made in order that the low water years in the 1890-1900 decade can be compared with the low water years in the 1920-1930 decade, or other decades, in order that high water years in various periods may be compared with high water years of other periods (R. 1574). The bar represents the total water supply of the year, which is segregated into three items where data is available. The red and green areas represent water consumption in Colorado; the stippled areas represent state line outflow from the Colorado area, or the unconsumed water; and the black portion represents the divertible water during the irrigation season of April to October for Kansas ditches, which is embraced in the outflow at the state line (R. 1575). The line marked "50% river depletion" is drawn through points half way down the various bars, and represents 50 percent of the water supply or river de-

AMOUNTS IN ACRE-FEET

ARKANSAS RIVER WATER SUPPLY IN COLORADO 1895 TO 1930

RECONSTRUCTED RIVER WITH OUTFLOW AT COLORADO — KANSAS LINE

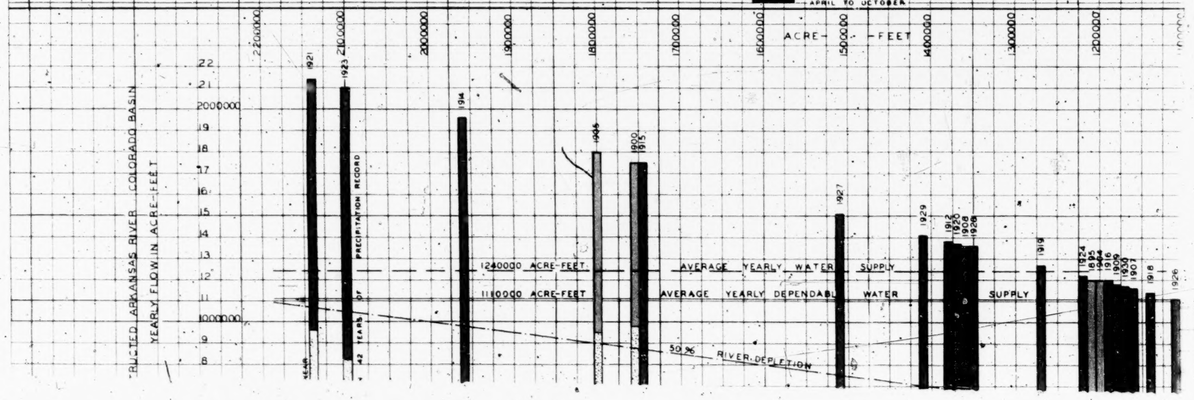
PREPARED FROM RECORDS OF RIVER FLOW OF U.S. GEOLOGICAL SURVEY + STATE OF COLORADO AND STATE OF KANSAS

BY MEEKER - IRRIGATION ENGINEER - DENVER COLORADO

ARKANSAS RIVER WATER SUPPLY COLORADO

HOLLY OUTFLOW SUPERIMPOSED ON WATER SUPPLY

LEGEND — COLORADO WATER SUPPLY
RIVER OUTFLOW AT HOLLY
WATER DIVERTIBLE - KANSAS CANALS APRIL TO OCTOBER

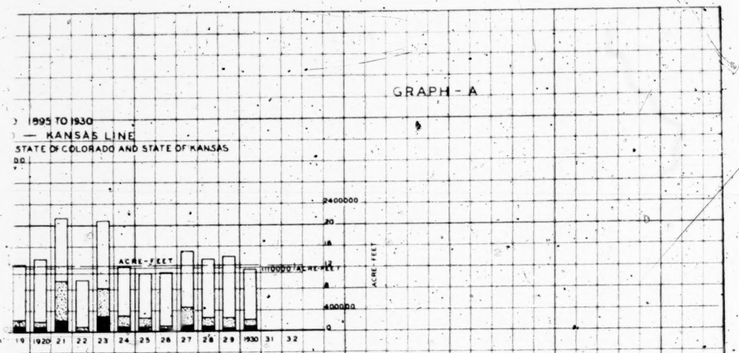


GRAPH - A

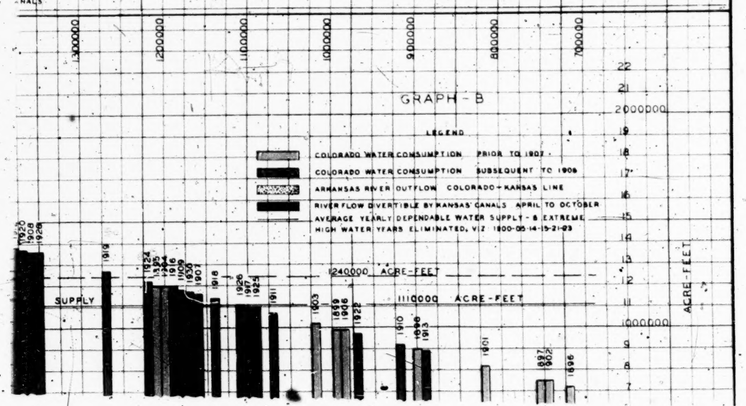
1895 TO 1930

— KANSAS LINE

STATE OF COLORADO AND STATE OF KANSAS



GRAPH - B



ARKANSAS RIVER BASIN IN COLORADO

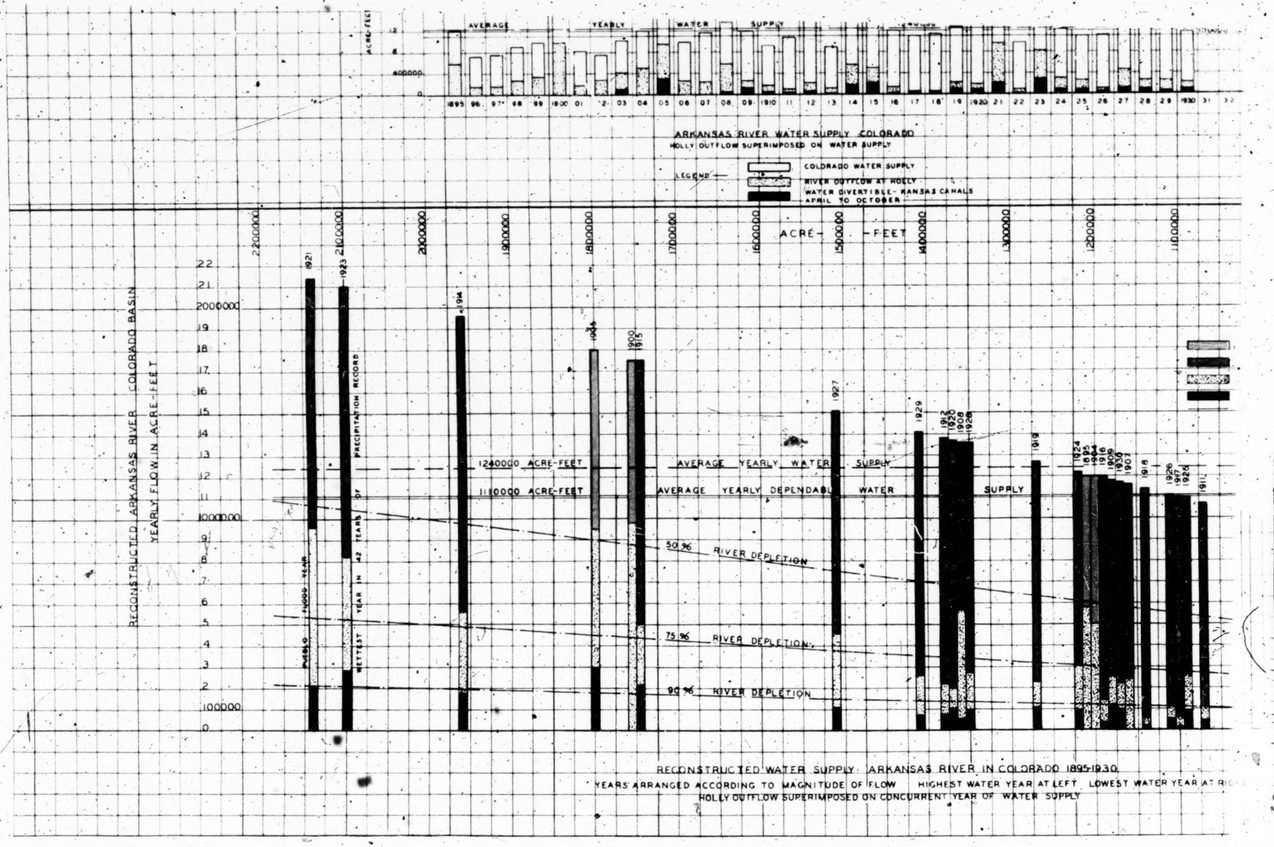
YEARLY WATER SUPPLY IN ACRE-FEET

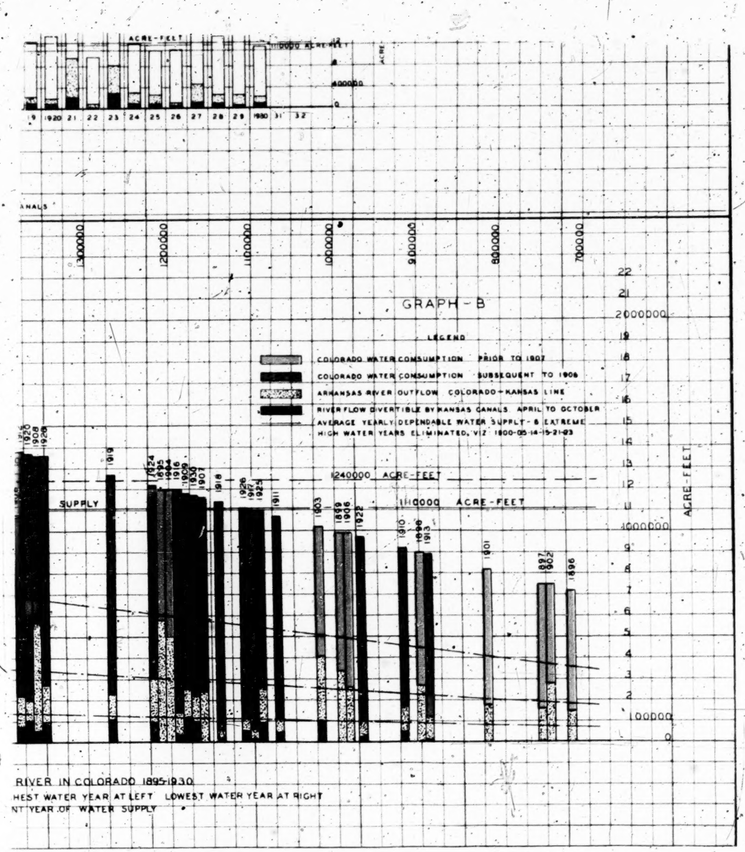
YEAR	COLORADO WATER SUPPLY	COLORADO WATER CONSUMPTION TOTAL	% OF YEARLY WATER SUPPLY	% OF AVERAGE YEARLY WATER SUPPLY 1240000	HOLLY OUTFLOW TOTAL	% OF YEARLY WATER SUPPLY	% OF AVERAGE YEARLY WATER SUPPLY 1240000
1895	1200000	620000	52	50	580000	48	47
96	720	570	79	46	150	21	12
97	750	590	79	48	160	21	13
98	900	630	70	51	270	30	22
99	990	650+	66	52	340	34	27
1900	1250000	770000	44	62	980000	56	79
01	820	640	78	52	180	22	15
02	750	470	63	38	280	37	23
03	1020	610	60	49	410	40	33
04	1200	700	58	56	500	42	40
1905	1800000	850000	47	68	950000	53	77
06	990	730	74	59	260	26	21
07	1160	920	79	74	240	21	19
08	1360	790	58	64	570	42	46
09	1180	930	79	75	250	21	20
1910	920000	750000	82	60	170000	18	14
11	1070	960	90	77	110	10	9
12	1380	1160	84	94	220	16	18
13	990	770	87	62	120	13	10
14	1960	1400	72	113	560	28	45
1915	1750000	1250000	72	101	500000	28	40
16	1200	1060	88	86	140	12	11
17	1100	1040	95	84	60	5	5
18	1140	1080	95	87	60	5	5
19	1270	1040	82	84	230	18	19
1920	1370000	1170000	85	94	200000	15	16
21	*2140	1180	55	95	* 960	45	77
22	970	870	90	70	100	10	8
23	*2100	1280	61	103	** 820	39	66
24	1220	920	75	74	300	25	24
1925	1100000	840000	76	68	260000	24	21
26	1110	1000	90	81	110	10	9
27	1510	1050	70	85	460	30	37
28	1360	1090	80	88	270	20	22
29	1410	1150	82	93	260	18	21
1930	1170000	950000	81	77	220000	19	18
AVERAGE	1240000	* PUEBLO FLOOD			** WETTEST YEAR IN 42 YEARS		

5 YEAR MEANS

1895-99	912000	612000	67	49	300000	33	24
1900-04	1108	638	58	51	470	42	38
1905-09	1298	844	65	68	454	35	37
1910-14	1244	1008	81	81	236	19	19
1915-19	1292	1094	85	88	198	15	16
1920-24	1560	1084	70	87	476	30	38
1925-29	1298	1026	79	83	272	21	22

10 YEAR MEANS





1900	1750000	770000	44	62	980000	56	79
01	820	640	78	52	180	22	15
02	750	470	63	38	280	37	23
03	1020	610	60	49	410	40	33
04	1200	700	58	56	500	42	40
1905	1800000	850000	47	68	950000	53	77
06	990	730	74	59	260	26	21
07	1160	920	79	74	240	21	19
08	1360	790	58	64	570	42	46
09	1180	930	79	75	250	21	20
1910	920000	750000	82	60	170000	18	14
11	1070	960	90	77	110	10	9
12	1380	1160	84	94	220	16	18
13	890	770	87	62	120	13	10
14	1960	1400	72	113	560	28	45
1915	1750000	1250000	72	101	500000	28	40
16	1200	1060	88	86	140	12	11
17	1100	1040	95	84	60	5	5
18	1140	1080	95	87	60	5	5
19	1270	1040	82	84	230	18	19
1920	1370000	1170000	85	94	200000	15	16
21	*2140	1180	55	95	* 960	45	77
22	970	870	90	70	100	10	8
23	**2100	1280	61	103	** 820	39	66
24	1220	920	75	74	300	25	24
1925	1100000	840000	76	68	260000	24	21
26	1110	1000	90	81	110	10	9
27	1510	1050	70	85	460	30	37
28	1360	1090	80	88	270	20	22
29	1410	1150	82	93	260	18	21
1930	1170000	950000	81	77	220000	19	18
AVERAGE	1240000	* PUEBLO FLOOD		** WETTEST YEAR IN 42 YEARS			
5 YEAR MEANS							
1895-99	912000	612000	67	49	300000	33	24
1900-04	1108	638	58	51	470	42	38
1905-09	1298	844	65	68	454	35	37
1910-14	1244	1008	81	81	236	19	19
1915-19	1292	1094	85	88	198	15	16
1920-24	1560	1084	70	87	476	30	38
1925-29	1298	1026	79	83	272	21	22
18 YEAR MEANS							
1895-1912	1109000	742000	67	60	368000	33	30
1913-1930	1376	1063	77	86	313	23	25

COLORADO WATER CONSUMPTION
FROM CURVE OF WATER CONSUMPTION EXHIBIT

PERIOD		ACRE-FEET
1880		100000
1890		280000
1898-1902	5 YR MEAN	630000
1903-1907	5 YR MEAN	760000
1908-1912	5 YR MEAN	920000
1913-1917	5 YR MEAN	1100000
1918-1922	5 YR MEAN	1070000
1923-1927	5 YR MEAN	1020000
1928-1930	3 YR MEAN	1060000

pletion, and shows when water consumption is either 50 percent or more. Likewize, the 75 percent line and the 90 percent line are drawn at points of three-fourths or nine-tenths of the bars, and likewise show when water consumption has attained those percentages. They are put there for ready comparison, so that one can readily see what the relation of the water consumption of the various types of years is to the water supply (R. 1577).

It will be noted that during the earlier period the water consumption of the high water and normal years follow closely the line of 50 percent, while the water consumption of the later high water years and normal years followed roughly the line of 75 percent river depletion, indicating an increase in river depletion of 25 percent of the water supply. Referring to the low water years of both periods, we find the water consumption during the earlier period generally was above the line of 75 percent depletion while during the later period it roughly approximated the line of 90 percent river depletion. Increased lands in Colorado with increased water diversions, and resultant increased water consumption in Colorado, is the reason for this apparent increase in water depletion. Reservoirs largely constructed since 1905 have

been an important factor in increasing water consumption (R. 1578).

All of the factors relating to depletion, the extent, the effect upon state line flow, the utility of such state line flow for irrigation in Kansas, and other allied facts, must for complete understanding be related back to the changing total water supply. Equal quantities of state line flow as between two given years does not mean that there was no change in depletion, since in one year the total quantum of water supply might be much greater than in another. Neither does a similarity in the number of days in two given years when water was not available for crop needs indicate lack of depletion, for again a shortage in the total quantum of water supply in one year would produce an identical situation, as where there was much greater depletion of a much more ample supply. Similar years must be compared and from them the effect of progressive river depletion judged.

The record, however, permits the comparison between years of similar water supply (see Kansas Exh. 62, page 1519, and Kansas Exh. 70, page 1569). Comparable years of water supply were: 1895 with 1,200,000 acre feet; 1904 with 1,200,000 acre-feet; and 1930 with 1,170,000 acre-feet. The respective outflow at Holly: 1895, 580,000

acre-feet, or 48 percent of the total supply; 1904, 500,000 acre-feet, or 42 percent of the total supply; and 1930, 220,000 acre-feet, or 19 percent of the state line flow; indicating a depletion in the state line flow of 360,000 acre-feet since 1895, and of 280,000 acre-feet since 1904 (R. 1585-'86). The year 1899 with 990,000 acre-feet of total water supply and 340,000 acre-feet in the state line outflow, or 34 percent of the water supply, as compared with 1922, with 970,000 acre-feet of water supply and 100,000 acre-feet of outflow, or 10 percent of the total supply, shows a depletion of 240,000 acre-feet in the state line outflow.

The years of 1903 with 1,020,000 acre-feet of supply and 610,000 acre-feet of state line outflow; and 1904 with 1,200,000 acre-feet of water supply and 700,000 acre-feet of state line outflow, can be compared with 1917, with 1,100,000 acre-feet of water supply and 60,000 acre-feet outflow, 1918 with 1,140,000 acre-feet of water supply and 60,000 acre-feet outflow, and 1926 with 1,110,000 water supply and 110,000 acre-feet outflow. In the two earlier years the average water supply was 1,110,000 acre-feet; the average of the three later years was 1,116,000 acre-feet. The average outflow of the two earlier years was 655,000 acre-feet; the average of the three later years was

76,000 acre-feet. The depletion of supply had increased by 579,000 acre-feet. In the earlier years the percentage of outflow to water supply was 59 percent. In the three later years the percentage of state line outflow to water supply was 6.8 percent.

If low water years in the earlier period, namely, 1898, 1899, 1903 and 1906, where the average water supply was 975,000, are compared with low water years in the later period, namely 1910, 1913, 1922, 1926, where the average water supply was 972,500 acre-feet, the ratio of state line outflow to water supply in the earlier years was 33 percent, that of the later years 13 percent.

If we take the three water years following the census of 1902 and down to conclusion of evidence in the Kansas-Colorado case, namely the years 1903, 1904 and 1905, and compare them with the last three years of which there is any water supply study, namely 1928, 1929 and 1930, the record shows the following: That the average water supply of the three years 1903 to 1905, inclusive, was 1,340,000 acre-feet, the average state line outflow 620,000 acre-feet. The average percentage of state line outflow to total average water supply was 46.2 percent. That the average water supply of the three years 1928 to 1930, inclusive, was 1,313,000 acre-feet. The average state line

outflow was 250,000 acre-feet, and the percentage of state line outflow to average total water supply was 19 percent.

Since the close of testimony in the original Kansas-Colorado suit the consumption of water in Colorado has increased to the extent of 300,000 acre-feet of the average yearly dependable water supply (R. 1742). The Colorado average consumption during the eleven years 1920 to 1930 was 1,045,000 acre-feet, approximately 95 percent of the dependable supply (R. 1521).

The foregoing story of water depletion amply justifies the statement of State Engineer Hinderlider of Colorado, "*practically all of the water escaping out of this valley into Kansas is the result of tributary flow entering the river in the lower reaches of the valley.*" (R. 1739.)

5. Character of Residual Flow into Kansas

Depletion of quantity is only a portion of the picture. Depletion in character or usability of what is left is the other. When the state engineer of Colorado spoke of water escaping into Kansas, he was speaking of vagrant water which could not be captured or used in Colorado. The character of flow, the continuity of flow, the distribution of flow with respect to its utility for agricultural purposes, all are related to and become integral parts of

the equitable right of the lower state to participate in the realization of benefits from such flow.

Defendants here propose to discuss depletion in terms of effect on the usability of state line flow. Depletion measured in terms of total water supply may reflect a 90 percent loss to the total supply, but if it is measured in terms of its effect on the character and kind of flow, it may reflect an almost total destruction of any practical benefits which can arise from the use of such flow.

The Supreme Court of the United States in announcing the doctrine of equitable apportionment clearly indicated that those benefits which each state has a right to enjoy on the basis of equity are those resulting from or which can be realized from the flow of the stream. What is controlling is that the continuity of stream flow be so maintained from the standpoint of utility, that from that flow Kansas may be able to realize therefrom such irrigation development and returns, as equity and justice give her a right to expect. The right of the State of Kansas to an equitable apportionment of the benefits resulting from the flow of the river is certainly not satisfied merely because a certain gross quantum of water escapes across the line into Kansas on the average each year unless the amount and character of the water which flows into Kansas is,

in such quantum and at such times, a fair percentage of the dependable and usable flow of the river as permits the enjoyment of benefits on an equitable basis with Colorado.

This is but another way of stating a principle already recognized by the courts. In *Kansas v. Colorado,* 206 U. S. 46, *supra,* the court said, "We must consider the effect of what has been done upon the conditions in the respective states and so adjust the dispute upon the basis of equality of rights as to secure as far as possible to Colorado the benefits of irrigation without depriving Kansas of *the like beneficial effects of a flowing stream.*" (Italics ours.)

Since, therefore, Kansas is entitled to enjoy like beneficial effects from the Arkansas River as Colorado, then certainly equitable apportionment of benefits from stream flow must be measured and equities determined by the character of flow utilizable for agricultural purposes, during the time when it is possible to utilize water for that purpose or beneficial use.

Comparisons are the only means available of balancing the equity of benefits derived from the flow of the River. While the diversions in and of themselves are not a measure of permanent depletion, balancing the facts with re-

spect to withdrawals of water in Colorado against the lack of opportunity for withdrawal in Kansas demands consideration.

a. Monthly Diversions in Colorado Compared with Divertible Water Passing Across the State Line

Page 1 of Colorado Exhibit 194 shows the average monthly diversions 1908 to 1938 of only those Colorado ditches which were recorded as taking water from the main river from Parkdale to the Kansas-Colorado line. It is to be noted that these diversions include only part of the diversions for irrigation in Districts 12, 14, 17 and 67, and do not include any diversions in Districts 10, 11, 13, 15, 16, 18 and 19, where the acreage diverting water for irrigation uses amounted in 1929 to 195,800 acres (see Kansas Exh. 57, page 1513; Kansas Exh. 24, page 1462), so that the recorded diversions here referred to represent only a part of the water diverted for irrigation use, and do not reflect any diversions for the 195,800 acres irrigated in these other portions of the basin. However, taking the April to October, inclusive, average of these recorded diversions which represent diversions for only a portion of the irrigated acreage in the basin, we find each monthly average to be as follows:

Month	*Acre-feet*
April	76,688
May	124,768
June	181,262
July	158,631
August	133,126
September	87,449
October	72,781

(Colorado Exh. 194, R. page 6562.)

We can compare these partial Colorado diversions, which do not include the diversions for the 195,800 acres irrigated along the tributaries, with the divertible water passing across the state line by months for the 31-year period 1908 to 1938, as reflected in Colorado Exhibit 211 (R. page 6647). By "divertible" we mean that water flowing in the stream which is susceptible to capture by the headgates of the combined irrigation ditches. This 31-year period April to October, inclusive, represents a total of 217 months. The Kansas opportunity for diversion is as follows: In 102 out of the 217 months the monthly divertible amount of water passing across the state line which could be put to irrigation uses was less than 5,000 acre-feet per month, and only 83 months when the divertible amount measured at the state line was 10,000 acre-feet.

In this same 31-year period there were four years out

of 31 when each of seven months, April to October, inclusive, fell below 10,000 acre-feet; and there were:

5 years when 6 of the 7 months were below a total of 10,000 acre-feet;
4 years when 5 of the 7 months were below a total of 10,000 acre-feet;
7 years when 4 of the 7 months were below a total of 10,000 acre-feet;
6 years when 3 of the 7 months were below a total of 10,000 acre-feet;
3 years when 2 of the 7 months were below a total of 10,000 acre-feet;
2 years when 1 of the 7 months was below a total of 10,000 acre-feet;
No years when all of the 7 months were above 10,000 acre-feet.

The foregoing breakdown by months shows the manner in which the Colorado water diversions so effectively deplete the water passing into Kansas, that little substantial benefit could be realized in the lower state through irrigation.

The first four months of the growing season are critical from the standpoint of irrigating crops. If crops do not have water enough to germinate and get started, the amount which is available from July on is of little use regardless of its quantity.

Colorado Exhibit 211 discloses that in seven years of 31 all of these first four months, April, May, June and July, had less than 10,000 acre-feet of divertible water passing the state line. There were 17 years of the 31-year period when three of the first four months had less than 10,000 acre-feet of divertible water passing the state line, with 13 of these years, when the three months

1917
MONTHLY PRECIPITATION
ARKANSAS VALLEY, COLORADO
PLAINS AREA, AVERAGE 11 STATIONS
O—O LONG TIME AVERAGE
X—X 1917 DEFICIENCY
EXCESS

INCHES

ACRE-FT. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. YEAR % ACRE-FT.

SECOND-FEET

WATER SUPPLY DISTRIBUTION
CANON CITY TO HOLLY COLORADO
ARKANSAS RIVER AT CANON CITY
REPORTED TRIBUTARY INFLOW
UNMEASURED WATER SUPPLY
ARKANSAS RIVER AT HOLLY
DITCH DIVERSIONS CANON CITY TO HOLLY

TOTAL WATER SUPPLY CANON CITY TO HOLLY
TOTAL DITCH DIVERSIONS CANON CITY TO HOLLY
ARKANSAS RIVER CANON CITY
ARKANSAS RIVER HOLLY

JAN. FEB. MAR. APR. MAY JUNE

KANS EX. 78

1917

HYDROGRAPH

Showing Conditions Affecting

ARKANSAS RIVER WATER SUPPLY CANON CITY TO HOLLY, COLORADO, NEAR KANSAS LINE.

Compiled from Official Records of the State of Colorado and the United States

By

Ralph L. Meeker,
Consulting Engineer for the State of Kansas

GROWING SEASON ARKANSAS VALLEY
WESTERN KANSAS 167 DAYS
EASTERN COLORADO 166 DAYS

LEGEND

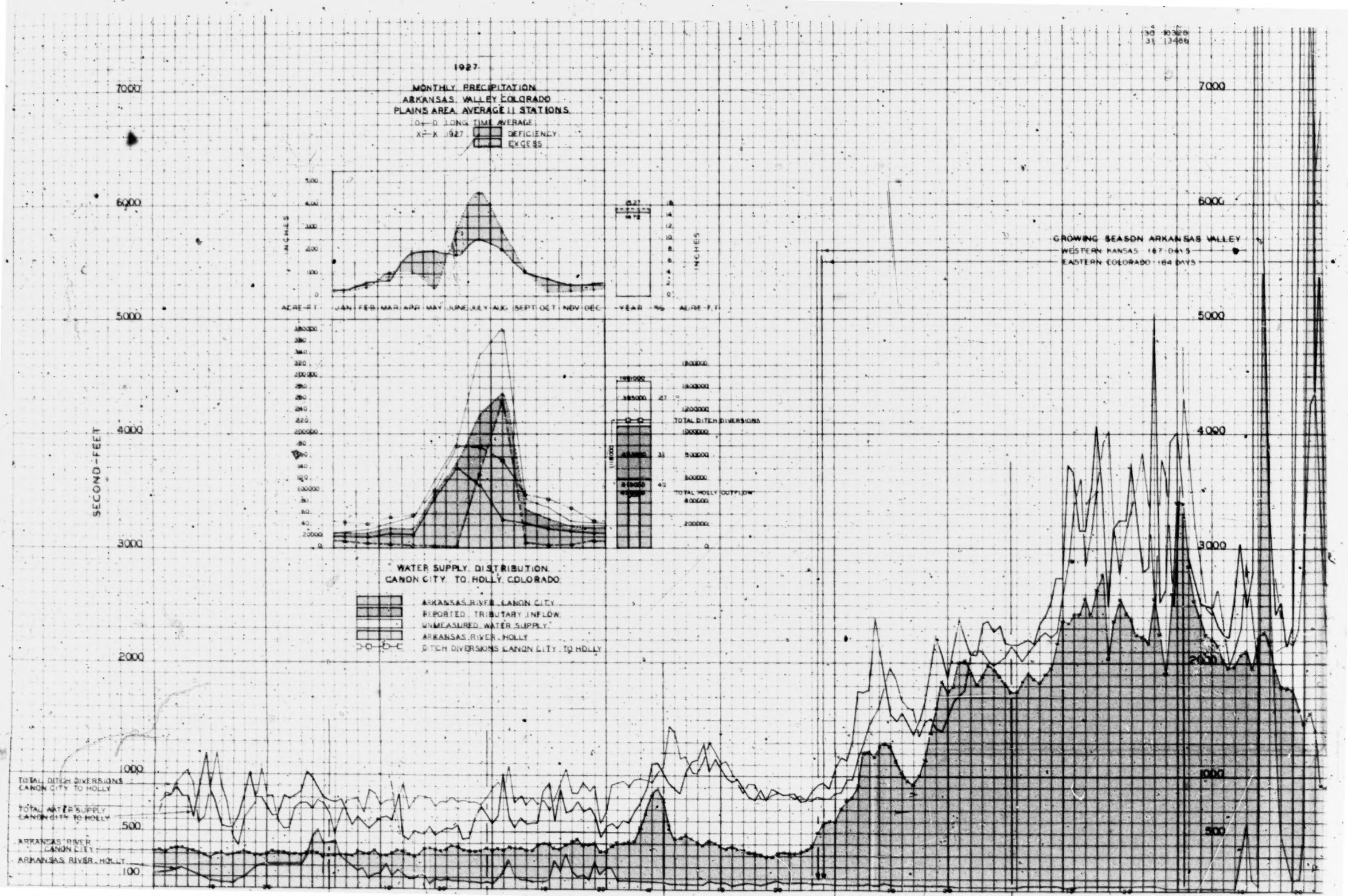
UNMEASURED INFLOW
ARKANSAS RIVER, CANON CITY
ARKANSAS RIVER, HOLLY
TOTAL DITCH DIVERSIONS
TOTAL WATER SUPPLY, CANON CITY TO HOLLY
ARKANSAS RIVER, CANON CITY
ARKANSAS RIVER, HOLLY

ARKANSAS RIVER TOTAL WATER SUPPLY CANON CITY TO HOLLY

7000
6000
5000
1000
500
100

TOTAL DITCH DIVERSIONS CANON CITY TO HOLLY
TOTAL WATER SUPPLY CANON CITY TO HOLLY
ARKANSAS RIVER, CANON CITY
ARKANSAS RIVER, HOLLY

JUNE | JULY | AUG | SEPT | OCT | NOV | DEC


1927
MONTHLY PRECIPITATION
ARKANSAS VALLEY COLORADO
PLAINS AREA AVERAGE 11 STATIONS
O—O LONG TIME AVERAGE
X—X 1927
DEFICIENCY
EXCESS
INCHES
ACRE-FT
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
YEAR
ACRE-FT
WATER SUPPLY, DISTRIBUTION
CANON CITY TO HOLLY, COLORADO
ARKANSAS RIVER, CANON CITY
REPORTED TRIBUTARY INFLOW
UNMEASURED WATER SUPPLY
ARKANSAS RIVER, HOLLY
DITCH DIVERSIONS CANON CITY TO HOLLY
TOTAL DITCH DIVERSIONS
TOTAL HOLLY OUTFLOW
GROWING SEASON ARKANSAS VALLEY
WESTERN KANSAS 187 DAYS
EASTERN COLORADO 184 DAYS
SECOND-FEET
TOTAL DITCH DIVERSIONS CANON CITY TO HOLLY
TOTAL WATER SUPPLY CANON CITY TO HOLLY
ARKANSAS RIVER CANON CITY
ARKANSAS RIVER HOLLY
7000
6000
5000
4000
3000
2000
1000
500
100

KANS. EX. 86

1927

HYDROGRAPH

Showing Conditions Affecting

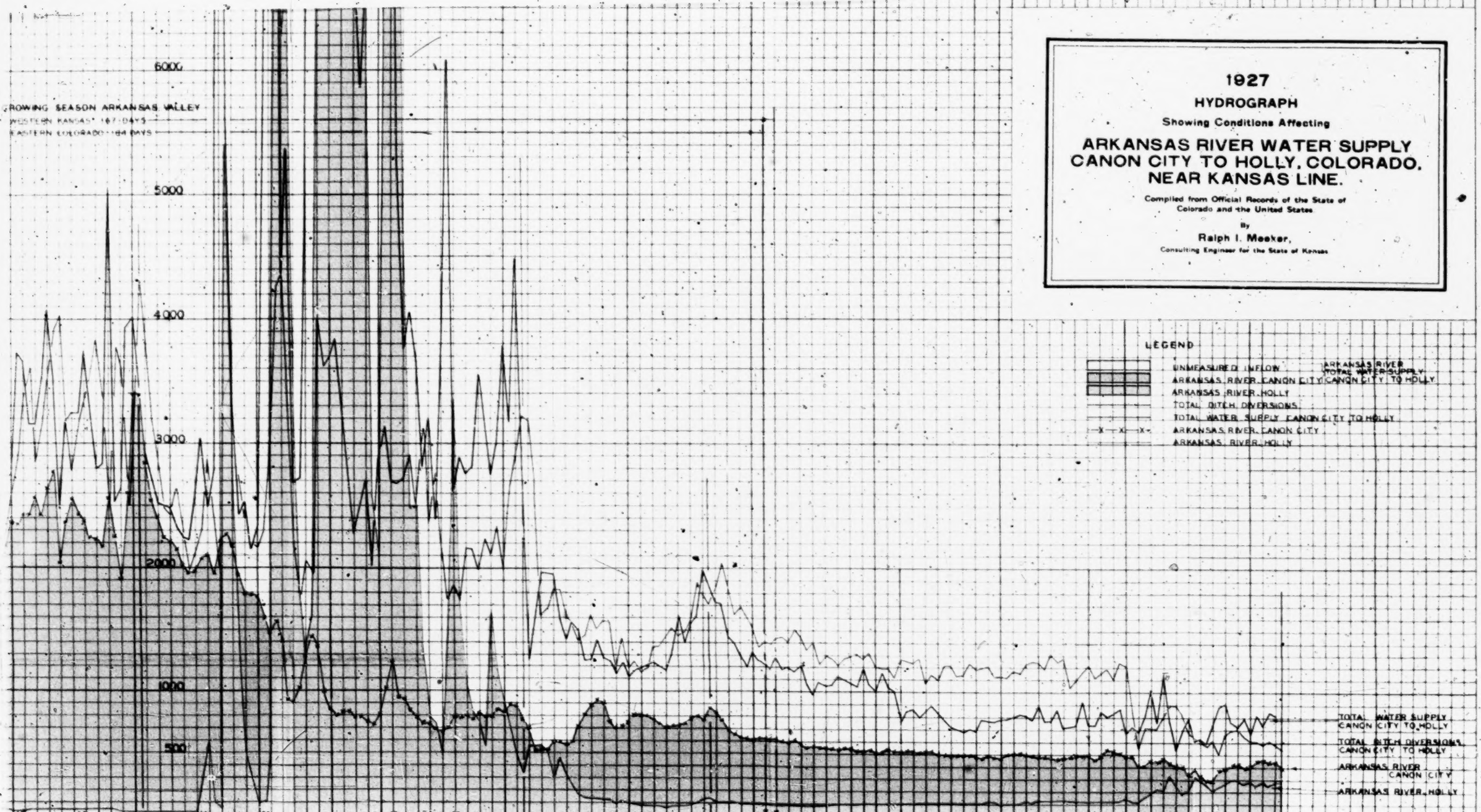
ARKANSAS RIVER WATER SUPPLY CANON CITY TO HOLLY, COLORADO. NEAR KANSAS LINE.

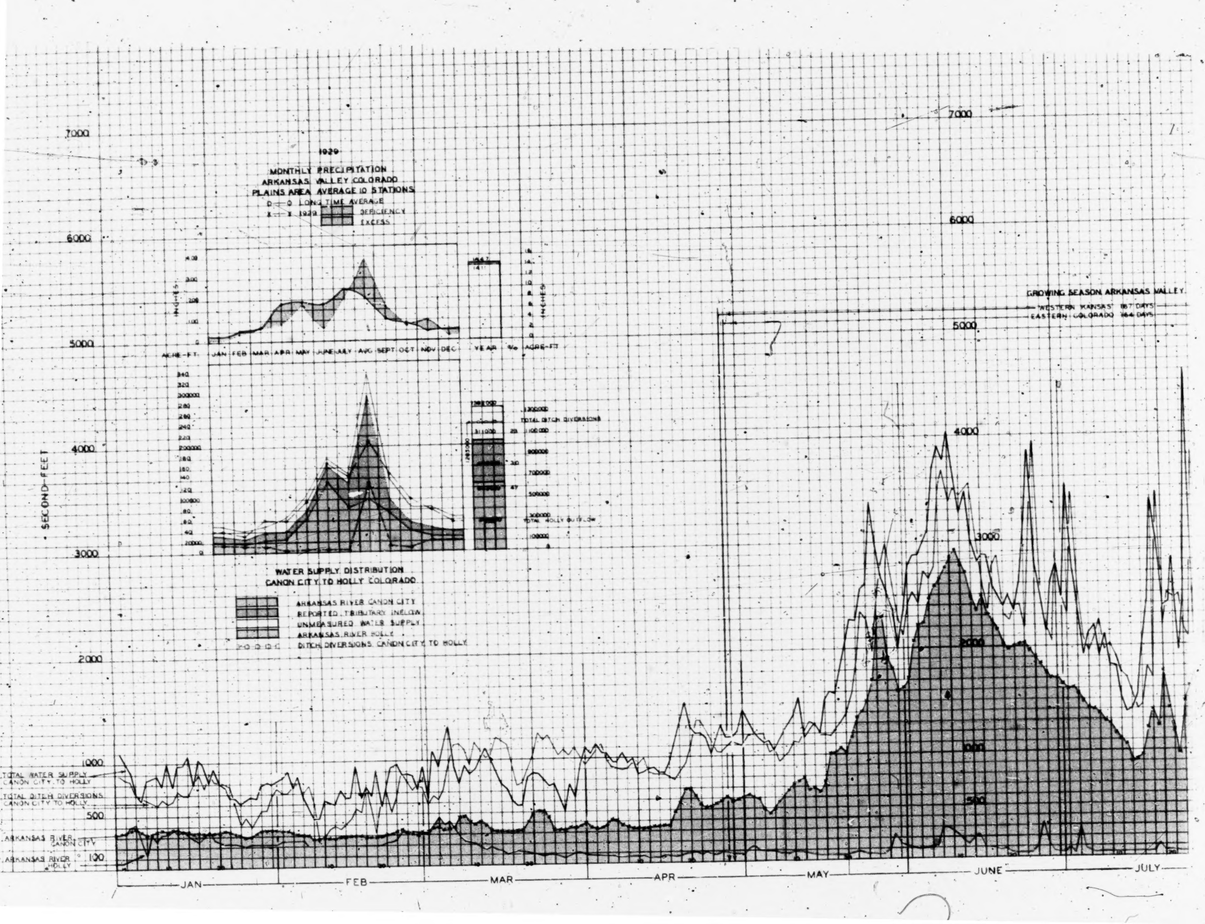
Compiled from Official Records of the State of Colorado and the United States

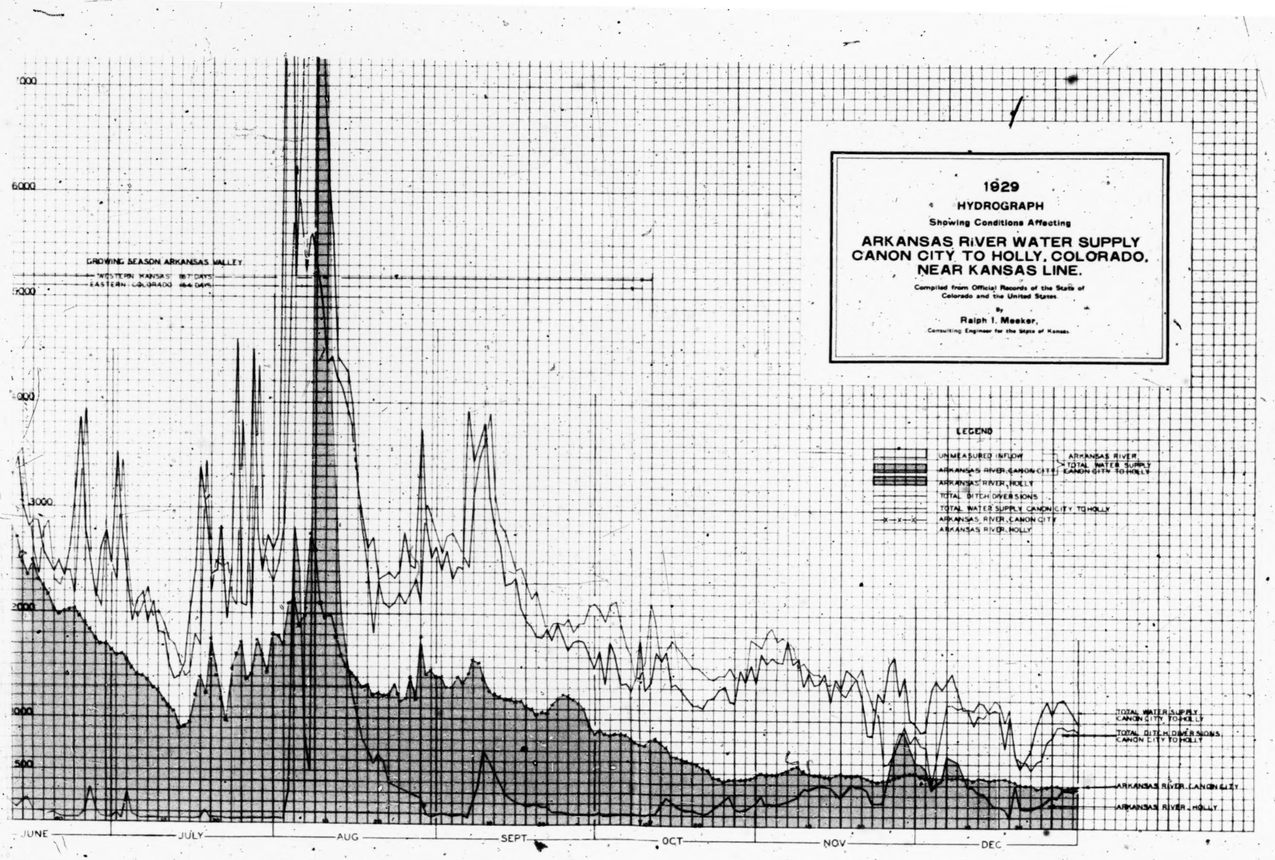
By

Ralph I. Meeker,

Consulting Engineer for the State of Kansas




1929
MONTHLY PRECIPITATION
ARKANSAS VALLEY COLORADO
PLAINS AREA AVERAGE 10 STATIONS
D---D LONG TIME AVERAGE
X---X 1929
DEFICIENCY
EXCESS
WATER SUPPLY DISTRIBUTION
CANON CITY TO HOLLY COLORADO
ARKANSAS RIVER CANON CITY
REPORTED TRIBUTARY INFLOW
UNMEASURED WATER SUPPLY
ARKANSAS RIVER HOLLY
DITCH DIVERSIONS CANON CITY TO HOLLY
GROWING SEASON ARKANSAS VALLEY
WESTERN KANSAS 187 DAYS
EASTERN COLORADO 184 DAYS
SECOND-FEET
TOTAL WATER SUPPLY CANON CITY TO HOLLY
TOTAL DITCH DIVERSIONS CANON CITY TO HOLLY
ARKANSAS RIVER CANON CITY
ARKANSAS RIVER HOLLY
JAN
FEB
MAR
APR
MAY
JUNE
JULY


1929
HYDROGRAPH
Showing Conditions Affecting
ARKANSAS RIVER WATER SUPPLY
CANON CITY TO HOLLY, COLORADO,
NEAR KANSAS LINE.
Compiled from Official Records of the State of Colorado and the United States
By
Ralph I. Meeker,
Consulting Engineer for the State of Kansas.
GROWING SEASON ARKANSAS VALLEY
WESTERN KANSAS 187 DAYS
EASTERN COLORADO 184 DAYS
LEGEND
UNMEASURED INFLOW
ARKANSAS RIVER TOTAL WATER SUPPLY CANON CITY TO HOLLY
ARKANSAS RIVER CANON CITY TO HOLLY
ARKANSAS RIVER HOLLY
TOTAL DITCH DIVERSIONS
TOTAL WATER SUPPLY CANON CITY TO HOLLY
ARKANSAS RIVER CANON CITY
ARKANSAS RIVER HOLLY
TOTAL WATER SUPPLY CANON CITY TO HOLLY
TOTAL DITCH DIVERSIONS CANON CITY TO HOLLY
ARKANSAS RIVER CANON CITY
ARKANSAS RIVER HOLLY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC

76, 86 and 88. These three years were selected because they portrayed graphically the character of the water supply in terms of flow of three different types of water supply years.

Kansas Exhibit 76, portraying the year 1917, represents a year where the basin water supply amounted to 1,100,000 acre-feet, or an amount substantially that found by the Special Master as the average annual dependable supply. Here consumption was so complete in Colorado that state line outflow amounted to only 59,400 acre-feet (Colorado Exh. 209, page 6640).

Kansas Exhibit 86, for the year 1927, represents a year when the water supply amounted to 1,510,000 acre-feet, the highest water supply year on record not eliminated in determining the average annual dependable supply. In this year the state line outflow amounted to 452,900 acre-feet (Colorado Exh. 209).

Kansas Exhibit 88, for the year 1929, represents a year when the water supply of the basin amounted to 1,410,000 acre-feet, a year of plentiful supply and yet a year when the water supply passing across the state line amounted to 250,800 acre-feet or an amount slightly less than the 30-year average (Colorado Exh. 209).

While the explanation of these three hydrographs ap-

pears on their face, it might be well to point out that in the upper left hand corner of each is a small graph portraying the occurrence of precipitation in the plains area of Colorado, showing differences above and below normal. Immediately below this appears a graph showing the monthly water supply distribution in terms of acre-feet. The main graph portrays the flow of the River from Canon City to Holly in terms of second-feet of daily flow. The black jagged line represents the Colorado ditch diversions as recorded from Canon City to Holly. The pink or red portion represents the flow of the stream as recorded at the Canon City gaging station where the Arkansas River emerges from the Royal Gorge. The yellow portion represents the contribution to the River flow in this stretch resulting from plains run-off. The blue portion represents the recorded state line outflow.

Examining the hydrograph for the year 1917 it will be observed that, although Colorado ditch diversions in this stretch of the stream alone, starting with 1,000 second-feet at the beginning of May and during July and August amounting to between 2,000 second-feet and 5,000 second-feet, the water supply opportunity in Kansas was practically worthless for irrigation purposes during the

entire growing season except for a slight spurt in the middle of August, and that the major portion of the 52,000 acre-feet passing across the state line came during the months of January and February.

Examining the hydrograph for the year 1927, during which year the total amount of water passing across the state line amounted to 452,900 acre-feet, an amount which on its face would indicate an ample water supply available for Kansas irrigators, we find that the entire amount was practically worthless for crop requirements. From the beginning of the growing season until the 10th day of July a mere trickle was available, generally approximating only 50 second-feet of flow.

By the 10th of July irrigated crops would have passed beyond redemption, and by the latter part of July and August the River flow, which constitu d practically all of the annual supply, would have been useless. 384,400 acre-feet passed across the state line in that limited period of time.

Turning to the hydrograph for the year 1929, an even worse situation is portrayed. During the year, from the beginning of the growing season through the months of May, June and July, a total of only 15,100 acre-feet was available for irrigation purposes (Colorado Exh. 209),

but in August 129,700 acre-feet flowed down the River in the space of a few days, too late for even the amount that could be captured to serve any practical irrigation use.

These hydrographs portray more effectively than words the necessity of a decree such as The Special Master recommends which will be adequate to make available and protect a dependable water supply to Kansas. While the remaining hydrographs differ in detail, except for a few excessive years in the entire period they tell the same story; but in order to place before the court the exact detail of flow the tables which follow represent a complete analysis of the entire period 1912 to 1931, inclusive.

The growing season in Western Kansas from killing frosts to killing frosts averages 167 days. In the 20 years dealt with by the hydrographs there were 3,340 days making up the total of the growing seasons. Of these on only 415 days did river flow go above 1,200 second-feet at the state line. There were during this period 1,905 days when the flow at the state line was less than 100 second-feet. They were:

462 days out of 3,340 above 1,000 second-feet
672 days out of 3,340 above 500 second-feet
818 days out of 3,340 above 300 second-feet
1,114 days out of 3,340 above 150 second-feet
1,445 days out of 3,340 above 100 second-feet
1,905 days out of 3,340 less than 100 second-feet
1,359 days out of 3,340 less than 50 second-feet

There is here submitted a series of five tables compiled from the hydrographs for the months of May to September, inclusive, covering the 20-year period 1912 to 1931, which show for each month of the 20-year period the facts of the record, contrasting the amounts of daily recorded ditch diversions from Canon City to Holly with the daily flow at the Kansas-Colorado state line.

COMPARISON OF RECORDED DIVERSIONS FROM RIVER, CANON CITY TO HOLLY, WITH TOTAL RIVER FLOW INTO KANSAS AT STATE LINE

MAY—20-YEAR PERIOD

(From Kansas Exh. 71 to 90, Inc.)

		Quantities of Water in Second Feet.	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	Total days.
Number of Days in Month when COLORADO'S Recorded Diversion from Canon City to State Line—	WERE	Above 3000 S. F.	2	26	26	16	2			12		1	4	1	12		8½		18				102½
		From 2000-3000 S. F.	6	3	5	12	12	7	2	14	9	18½	7	4	15	4	14½	7	7	8	2½		157½
		From 1000-2000 S. F.	17	24		3	17	23	21	5	22	12½	19	19	4	19	8	21	6	21½	28½		290½
		From 750-1000 S. F.	6	4				1	8				1	7		8		3		1½			39½
Number of Days in Month when Water passing across the State Line in Kansas—	WAS	Above 1000 S. F.			19	11				6				3		1	1½		8		4		53½
		From 500-1000 S. F.			5	11				1			1½		4	2½	1½		2		½		29
		From 200- 500 S. F.			4	4				5	3½	0	7½	1	8	4½	11		13	½	6½	12	80½
		*Below 200 S. F.	31	31	3	5	31	31	31	19	27½	31	22	27	19	23	17	31	8	30½	20	19	457

* Of the 457 days shown below 200 second feet, 313 or 68.5% were below 50 second feet.

were successive. There were 21 years of the 31-year period with two successive months of the four months, April to July, inclusive, below 10,000 acre-feet. Further analysis of this exhibit shows that in 17 of these 31 years the April, May and June divertible river flow averaged 5,440 acre-feet per month; and that in 18 of the 31 years the April, May, June and July average per month was only 7,280 acre-feet.

b. The Utility of State Line Flow for Irrigation

Averages of state line outflow presents only one part of the picture with respect to its effect on the opportunities to carry on irrigation from the water supply of the Arkansas River in the arid region in Western Kansas. The quantity of water passing across the state line, even monthly averages, does not represent its usability for irrigation. The opportunity to benefit from the flow is one of the primary equities.

Average amounts of water passing across the state line, average amounts of water during the growing season, and gross river depletion, do not present a complete understandable picture of the handicaps of irrigation in Kansas, by reason of the depletion of river flows upon the irrigation opportunity from a practical standpoint. Gross quantities of water expressed in terms of acre

feet per growing season, or annually, or monthly, do not show the value of such amounts of water for irrigation purposes (R. 1589). Crops are not grown with annual divertible amounts of water, nor yet with average divertible amounts during the growing season. River flows are not uniform—they vary from day to day, and flood spurts are of frequent occurrence. Ditch capacities are limited, and flood flows are flashy in character, and of a few days duration. A large portion of the water measured in terms of acre-feet may pass the headgate of a given ditch in two or three days time, with but small percent divertible, due to the limited capacity of the ditch. It is necessary to portray daily river performance in second feet, and to compare monthly irrigation requirements in second-feet in specific areas (R. 1590).

One of the primary requirements for irrigation is a continuous and adequate water supply from month to month and day to day during the irrigation season (R. 1591). The river supply passing into Kansas is non-uniform, consisting of flood spurts, from rains on the plains area, and of a duration, intermittent in character (R. 1591).

In dealing with a water supply largely produced

through flood spurts two factors must be especially considered:

First, that although a large quantity of water might be flowing in the river for a period of a few days, the amount that can be captured depends upon the combined headgate capacity of all the ditches.

Second, the usability of water so captured is dependent upon whether or not the ditches were dry before the flood spurt. If dry, there would be considerable losses in getting water to the land, and distribution through laterals would likewise consume considerable water. Losses are much greater when the ditch has been dry and water is run (R. 1606). Canal losses under ordinary conditions are about 20 percent, 25 percent, or 30 percent, depending on the soil. When dry ditches, probably 35 percent or 45 percent might be lost (R. 1606).

The day by day situation of river flow at the Kansas-Colorado line is accurately portrayed by hydrographs (Kansas Exh. 71, page 1618; Kansas Exh. 72, page 1623; Kansas Exh. 73, page 1627; Kansas Exh. 74, page 1630; Kansas Exh. 75, page 1634; Kansas Exh. 76, page 1636; Kansas Exh. 77, page 1638; Kansas Exh. 78, page 1640;

Kansas Exh. 79, page 1643; Kansas Exh. 80, page 1646; Kansas Exh. 81, page 1649; Kansas Exh. 82, page 1650; Kansas Exh. 83, page 1653; Kansas Exh. 84, page 1656; Kansas Exh. 85, page 1659; Kansas Exh. 86, page 1663; Kansas Exh. 87, page 1665; Kansas Exh. 88, page 1671; Kansas Exh. 89, page 1680; and Kansas Exh. 90, page 1684). These hydrographs show the rainfall conditions month by month, and in annual totals, in Colorado; they show the Canon City flow day by day, which flow is the supply most effective for irrigation uses during the early period of the growing season, since it is largely composed of mountain runoff; they portray the total additions to the water supply from the plains runoff, and tributary inflow; they show the daily ditch diversions by the Colorado ditches to the extent that they have been officially recorded, and they show the day by day amount passing across the state line into Kansas. These hydrographs extend from 1912, the date of the beginning of the first fairly complete records ascertainable, down through the year 1931. The exhibits deal with the water supply and diversions from Canon City to the state line.

Defendants are attaching three of these hydrographs for the convenience of the court, which are reproductions, although reduced somewhat in size, of Kansas Exhibits

COMPARISON OF RECORDED DIVERSIONS FROM RIVER, CANON CITY TO HOLLY, WITH TOTAL RIVER FLOW INTO KANSAS AT STATE LINE

JUNE—20-YEAR PERIOD

(From Kansas Exh. 71 to 90, Inc.)

		Quantities of Water in Second Feet	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	Total days.
Number of Days in Month when COLORADO'S Recorded Diversion from Canon City to State Line—	WERE	Above 3000 S. F.	30	6	25	18		19	16	7	28		22	24	25		20	15½	16	10	2		283½
		From 2000-3000 S. F.		18	3	6	23	11	10	19	2		8	6	5	3½	6	14½	14	20	24		193
		From 1000-2000 S. F.		6	2	6	7		4	4		10				26½	4				4		73½
		From 750-1000 S. F.										10											10
Number of Days in Month when Water passing across the State Line in Kansas—	WAS	Above 1000 S. F.	6	1	21	18	½					26		12	8½	1½	2		16				114½
		From 500-1000 S. F.	6	1	5	4								5	6½	3	13		8				51½
		From 200- 500 S. F.	3	3	4	3	3½		5		2			4	5	1½	7		2	4	3	3	53
		*Below 200 S. F.	15	25		5	26	30	25	30	28	4	30	9	10	24	8	30	2	26	27	25	379

*Of the 379 days shown below 200 second feet, 236 or 62.2% were below 50 second feet.

COMPARISON OF RECORDED DIVERSIONS FROM RIVER, CANON CITY TO HOLLY, WITH TOTAL RIVER FLOW INTO KANSAS AT STATE LINE

JULY—20-YEAR PERIOD

(From Kansas Exh. 71 to 90, Inc.)

		Quantities of Water in Second Feet.	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	Total days.
Number of Days in Month when COLORADO'S Recorded Diversion from Canon City to State Line—	WERE	Above 3000 S. F.	3	24	6	9	3	15	7	5	15	2	22	23		12	8	14	7	3			158
		From 2000-3000 S. F.	11	6	25	14	13	14	15	12	10	24	20	8	18	6	11	14	8	17	10		256
		From 1000-2000 S. F.	17	1		8	15	2	9	14	6	7	9		13	13	12	2	16	11	21		176
		From 750-1000 S. F.																					
Number of Days in Month when Water passing across the State Line in Kansas—	WAS	Above 1000 S. F.		2	14	1½					4	30		14		13½		13	2				94
		From 500-1000 S. F.	2		1	7½				1	5	1		3		1½	2	1	½				25½
		From 200- 500 S. F.	5	2	2	11			7	8	7			2		3	4½	6	1½	1			60
		*Below 200 S. F.	24	27	14	11	31	31	24	22	15		31	12	31	13	24½	11	27	30	31	31	440½

* Of the 440½ days shown below 200 second feet, 285 or 64.8% were below 50 second feet.

COMPARISON OF RECORDED DIVERSIONS FROM RIVER, CANON CITY TO HOLLY, WITH TOTAL RIVER FLOW INTO KANSAS AT STATE LINE

AUGUST—20-YEAR PERIOD

(From Kansas Exh. 71 to 90, Inc.)

		Quantities of Water in Second Feet	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	Total days.
Number of Days in Month when COLORADO'S Recorded Diversion from Canon City to State Line—	WERE	Above 3000 S. F.	7		15	7	5			4			8	15		4		3		14			82
		From 2000-3000 S. F.	7		5	14	17	9	2	5	22	20	3	7	1	9	7	25	9	16	6		184
		From 1000-2000 S. F.	17	19	11	10	9	22	29	20	9	11	19	9	30	18	24	3	22	1	25		308
		From 750-1000 S. F.		12						2			1										15
Number of Days in Month when Water passing across the State Line in Kansas—	WAS	Above 1000 S. F.	8		12	16	4			2½	9½	21	1	28½		5		20½		10	2		140
		From 500-1000 S. F.	4		3	6	2	1		4	5½	6	4	½		6		.8		7	3		66
		From 200- 500 S. F.	4		2	3	3	1	1	3½	2	4	6	2		5		1½		8	12		58
		*Below 200 S. F.	15	31	14	6	22	29	30	21	14		20		31	15	31		31	6	14	31	361

*Of the 361 days shown below 200 second feet, 238 or 65.9% were below 50 second feet.

COMPARISON OF RECORDED DIVERSIONS FROM RIVER, CANON CITY TO HOLLY, WITH TOTAL RIVER FLOW INTO KANSAS AT STATE LINE

SEPTEMBER—20-YEAR PERIOD

(From Kansas Exh. 71 to 90, Inc.)

		Quantities of Water in Second Feet.	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	Total days.
Number of Days in Month when COLORADO'S Recorded Diversion from Canon City to State Line—	WERE	Above 3000 S. F.																					
		From 2000-3000 S. F.						3	2		4	4		12		1		2		18	c 9		55
		From 1000-2000 S. F.	20	14	30	30	25	25	28	24	26	24	6	18	4	21	1	28	12	4	21		351
		From 750-1000 S. F.	10	16			5	2		6		2	24		26	8	29		18	8			154
Number of Days in Month when Water passing across the State Line in Kansas—	WAS	Above 1000 S. F.	3								1			27									31
		From 500-1000 S. F.	½			2	2				.8			3				3		3	7		38½
		From 200- 500 S. F.	2½			19	4	1	2½	3	8	3				3		5		8	8		55
		*Below 200 S. F.	24	30	30	18	24	29	27½	27	13	27	30		30	27	30	22	30	22	15	30	485½

* Of the 485½ days shown below 200 second feet, 287 or 59.1% were below 50 second feet.

(100)

c. Effect of Diversions for Storage in Colorado on State Line Flow

A part of this invasion of Kansas' equitable share of the water supply which contributes to the over-all effect is that of reservoir storage. A knowledge of the performance of reservoirs is necessary because of the changes in river flow resulting from storage and release in various parts of the river basin, and the resultant effect on state line outflow (R. 1523).

If reservoirs are used to store water in years of low runoff the effect of the Colorado reservoirs has been to diminish materially the river flow during the growing season which passes into Kansas (R. 1525). The water impounded in reservoirs is largely lost to the stream flow outside the state (R. 1525). Evaporation of water stored in reservoirs in the plains area is heavy during the summer months, and is a total loss to irrigators in Colorado and Kansas (R. 1525). The manner in which this form of water depletion takes place in Colorado without regard to the requirements in Kansas for water for direct irrigation uses, is shown by such evidence as is available reflecting the storage gains of reservoirs in Colorado and the time when storage takes place. At page 664 of the transcript of record in the original Kansas-Colorado case, as to the

construction of reservoirs in Colorado, Mr. Carpenter (main witness for the State of Colorado) says, quoting Major Powell:

> "The irrigating season on this river is, on an average, something more than two months, while the waters run to waste for more than nine months. It is this waste water that is to be stored in the mountains. Whatever is thus stored will decrease the volume passing the Kansas-Colorado line during the nonirrigating season, but will greatly increase the volume passing that line during the irrigating season; and, as in the case of the South Platte, *the prospect for irrigation in western Kansas depends upon the storing of water in Colorado. The greater the storage the greater will be the area irrigated in Kansas.*"

Such statement has in fact proved to be erroneous in view of the fact that all such storage has been used in Colorado and has acted to deplete the available water supply in Kansas.

Reservoir storage in Colorado during the growing season generally deprives Kansas irrigators of water (R. 1525). The administrative practice in Colorado is such that water can be impounded in reservoirs only when it is not required for direct irrigation. As long as a man wants to exercise his priority and divert water, and has a need for water, the reservoir cannot divert it. The

irrigator's demand for direct river flow must be first satisfied from stream flow before a reservoir has a right to impound water from the same source (R. 1527). No consideration whatever is given to whether irrigation needs in Kansas have been satisfied before impounding is permitted to take place in Colorado (R. 1527). Thus, the irrigator in Kansas secures water from river flow during the growing season only when the needs of all the Colorado irrigators in Colorado have been satisfied, or when the reservoir storage is filled, or else when there is such flash flow in quantity for a few days in the river that (Colorado) canal capacities are insufficient to divert it either for irrigation or storage purposes (R. 1527). There are many instances during the irrigating season when the water supply in Kansas is woefully inadequate for irrigation needs, while impounding is actually taking place in Colorado (R. 1553).

The opportunity for storage in Colorado can be exercised prior to the opportunity to divert water for irrigation in Kansas. This imposes a further depletion of water opportunity on Kansas users to the extent of their ability to divert water runs not demanded by the Colorado ditches for direct diversion for irrigation uses which otherwise would pass into Kansas.

It is unfortunate that failure of Colorado to maintain records of the actual amount of water stored prevents detailed certainty, but records are available from 1912 to 1931 with the exception of two years of the amount of water in storage in Colorado reservoirs on November 1 of each year. This does permit us to secure a general picture of the amount withheld from Kansas use during the irrigation season, since such amounts as the records show were stored and held over till the next season can be compared with the use of water in Kansas during the period of crop needs, from which use water was withheld for storage above. A tabulation making this comparison follows. The record shows that while Colorado diversions during May, June and July were reducing state line outflow to a point where its practical use for irrigation purposes was almost impossible, there was being built up in Colorado reservoirs thousands of acre-feet of storage water, withheld from stream flow for carry over to the following year.

	Water Storage in Arkansas Basin Reservoirs in Colorado on November 1. (R. 1554-1555)	*Number of Days during May to September period when State Line Flow was less than 200 second-feet (Tables pages 98 to 100 of brief)*
1912	131,000 acre-feet	109 out of 152 days
1913	29,000 acre-feet	144 out of 152 days
*1914	181,000 acre-feet	61 out of 152 days
*1915	488,000 acre-feet	45 out of 152 days
1916	145,000 acre-feet	134 out of 152 days
1917	Report imcomplete	150 out of 152 days
1918	105,000 acre-feet	137½ out of 152 days
1919	No published report	119 out of 152 days
1920	137,000 acre-feet	97½ out of 152 days
*1921	176,000 acre-feet	61 out of 152 days
1922	49,000 acre-feet	133 out of 152 days
*1923	396,000 acre-feet	48 out of 152 days
1924	135,000 acre-feet	121 out of 152 days
1925	117,000 acre-feet	102 out of 152 days
1926	86,000 acre-feet	110½ out of 152 days
1927	194,000 acre-feet	94 out of 152 days
1928	194,000 acre-feet	98 out of 152 days
1929	239,000 acre-feet	144½ out of 152 days
1930	193,000 acre-feet	107 out of 152 days
1931	37,000 acre-feet	136 out of 152 days

*Years omitted from Meeker's determination of dependable water supply, because exceptionally high water years.

Of these years above tabulated there are seven years, 1926-1931, when due to monthly reports the net gain by months is reflected. These records were started in 1926.

A tabulation of only the net increases in water storage annually, and the net quantities stored for the period May to August, taken from Colorado Exhibit 146, is as follows:

Year	Net Gain in Storage May, June, July and August	Net Gain for Year
1926	94,100 acre-feet	179,400 acre-feet
1927	189,500 acre-feet	260,300 acre-feet
1928	234,700 acre-feet	292,500 acre-feet
1929	112,600 acre-feet	304,600 acre-feet
1930	39,400 acre-feet	142,300 acre-feet
1931	8,800 acre-feet	83,400 acre-feet
1932	37,545 acre-feet	75,100 acre-feet

Actual amounts of water stored were necessarily far greater than the above tabulation shows. This is because drawoff during the irrigation season for irrigation is heavy and the losses through evaporation great. Particularly during the period May to August inclusive water is generally being withdrawn for irrigation. The amounts in the above table are net gain only, the quantity of actual withdrawal for storage from stream-flow to replace all quantities used cannot be ascertained. The effect of this river depletion on Kansas irrigation is indicated by a comparison in tables on pages 96 to 100, inclusive. In 1926, during the May to August period, during which 94,100 acre-feet were impounded, there were 81 days of the May to August period in which the flow across the state line was less than 200 second-feet, and of these 47 were less than 50 second-feet. During the same period, 1927, when 189,500 acre-feet were impounded, there were 72 days, May to August, inclusive, when the flow across

the state line was less than 200 second-feet, and of these 70 were less than 50 second-feet. In the same period, 1928, when 234,700 acre-feet were impounded, there were 68 days, May to August, inclusive, when the flow across the state line was less than 200 second-feet, and of these 32 were less than 50 second-feet. In the same period, 1929, when 112,600 acre-feet were impounded, there were 93 days, May to August, inclusive, when the flow across the state line was less than 200 second-feet, and of these 44 were less than 50 second-feet. In the same period, 1930, when 39,400 acre-feet were impounded, there were 92 days, May to August, inclusive, when the flow across the state line was less than 200 second-feet, and of these 49 were less than 50 second-feet. In 1931, when 8,800 acre-feet were impounded, there were 106 days, May to August, inclusive, when the flow across the state line was less than 200 second-feet, and of these 66 were less than 50 second-feet.

These figures, comparing the net increases to storage during the very heart of the growing season in Colorado, and the flow across the state line day by day, show something of the effect of diversions for storage alone in Colorado upon the water supply now reaching Kansas, and from which diversions in Kansas must be made.

Defendants have dealt at length and somewhat specifically on the foregoing factors, not only because they amply support the Master's Finding of Fact 5, but likewise for the reason that they support the requested additional finding of fact contained in defendants' Exception 7 as follows:

> "Colorado, being the upper state, has the first opportunity to divert and use the waters of the Arkansas River for irrigation purposes, and has so diverted and used said waters to the extent that users in Kansas have been deprived of practically all of the dependable flow of the stream. Such water as at present passes across the state line into Kansas consists of flash floods of a day or a few days duration, most of which is not subject to diversion or use. Water which can be captured from such floods is intermittent and bears little or no relation to crop requirements."

F. EFFECT OF CADDOA RESERVOIR

(Relating to Exception 3)

Even the limited erratic water supply which the record shows passed into Kansas may now be curtailed. This results from the construction and operation of Caddoa Reservoir in Colorado but recently put into operation.

This is a channel reservoir which is able to completely obstruct the flow of the river at a point approximately 50 miles from the Kansas-Colorado line. It will have a capacity when finished of 655,000 acre-feet. It has a present completed capacity of 270,000 acre-feet. This reservoir was built at government expense.

The State of Kansas objected to the evidence respecting this project because it was felt that the equitable apportionment of the natural water supply between the two states was a matter to be determined by consideration of the basic equities, and not be confused by factors not existing at the time the issues were formed, nor being a factor upon which the need or the rights of either state could be determined. The evidence shows that this reservoir has only a limited life of approximately 60 years (R. 6884). These objections were based on the fact that any decree quieting the rights of the respective states in and to the waters of the River which had embodied in its considerations this purely temporary achievement would have embodied therein a fatal defect as a permanent adjudication of rights.

All water which heretofore has constituted river flow at that point will be compelled to pass through the reservoir, and can there be impounded. In the area above

that point, which includes most of the Colorado tributaries, and which heretofore permitted some diversion by Kansas ditches in the few days in which such water passed their headgates, can now effectively be captured in this reservoir. Water which passes down stream below that point will be either water released or flood spills when the conservation pool is filled to capacity, which on the basis of Colorado's Exhibit 222, page 6750, would have occurred in only nine out of 31 years on an assumed operation of this structure from 1908 to 1938.

The completion of this reservoir may be used to restrain the majority of those vagrant waters which State Engineer Hinderlider described as escaping into Kansas. State line flow may thereafter be reduced to a few flash floods which might join river flow in the 50 mile strip to the state line. Thus, substantially complete river depletion within Colorado will have become effective.

The facts show that it is not necessary for the gates to be operated to bring about a part of the above described depletion, since even without the installation of gates to be closed for operating purposes the openings in the dam structure are such as to limit and circumscribe the natural flow within certain bounds. The ditches in Colorado below the reservoir have a combined

headgate diversion capacity of 1,712 cubic feet per second. In the years excepting those so-called "big water years" the unregulated operation of the structure would be such as to reduce the quantity of water that is able to pass through its open gates to a point where the total amount passing through could practically all be used by Colorado ditches below the reservoir (R. 7010). In that case the water passing the state line would be such water as comes in from flash floods from the tributaries below the last of the Colorado ditches.

The water produced below Caddoa cannot be controlled in any way by this reservoir. The flow originating below Caddoa, particularly the summer flow, is very erratic. A storm may occur over that portion of the basin and there will be a heavy flow for one or two days, and then as far as the natural water of that area is concerned it may be weeks, or even several months, in the summer until there is an appreciable summer runoff in that part of the drainage basin (R. 7072).

After construction of the gates, if the gates and the conduits are closed and used to regulate the flow of the stream, the structure can regulate the flow of the river from any desired releases from one or two cubic feet

per second, up to 1,000 feet or more, depending on storage in the reservoir (R. 7008).

The years when the conservation pool up to spillway crest might not control the water if releases were made as rapidly as diversions could be made below, is indicated in Colorado Exhibit 202 showing flood spills. In nine years of the 31 indicated there would have been flood spills ranging from a small amount to large amounts, and that would be very nearly the number of years and the same years when Caddoa could not be operated to completely control the stream below (R. 7009).

As stated above in the years excepting those so-called "big years" the structure could be operated so as to regulate the supply of water passing through it to a point where it could all be used by the Colorado ditches below the reservoir (R. 7010).

We do not intend by the foregoing statements to indicate a permanent condition, since the record indicates an effective life of this reservoir of approximately 60 years (R. 6687). According to Mr. Patterson, the rate of siltation is 6,330 acre-feet per year. There is a substantial agreement on this siltation rate by Mr. Knapp, State Engineer of Kansas, and on such basis we can

accept as a fact that the probable life of the reservoir will not be more than a few years at the most longer than the 60 years set by these men.

The Caddoa reservoir belongs neither to Kansas nor Colorado. As a factor in this interstate water problem it will function on the same basis as every other reservoir constructed in Colorado in the Arkansas basin as a unit of regulation to capture surplus flood waters, and thereby complete in the most effective means possible the depletion of stream flow into Kansas. The capacity of the conservation pool, 385,000 acre-feet, represents its depletion possibility. Like the other 33 reservoirs in Colorado, with a storage capacity of 539,151 acre-feet, it represents purely an additional agency for depletion of water supply into Kansas. It is not an element which has any part in determining what equitable apportionment of the water supply should be adjudicated as belonging to the State of Kansas in her sovereign capacity. Only when a decree is entered, upon the basis of which delivery of water to Kansas can be compelled, does it enter this controversy, and then only as an agency along with other Colorado reservoirs or other Colorado sources of supply whereby replacement of water withheld from

Kansas can be replaced in a practical and effective manner.

The contemplated use of this reservoir is indicated in the 24th biennial report of the State Engineer of Colorado, where it was said, "It has been estimated that this reservoir should equalize the discharge of the river at a point to an average annual delivery of 153,000 acre-feet, the use of which would develop an additional 50,000 acre-feet of return flow, making a total of 200,000 acre-feet of additional water supplies now badly needed to supplement existing decrees. This usage of water would be made possible through a system of exchange above the reservoir and upstream canals." This statement not only reflects the estimated amount of the State Engineer of Colorado, but the intention at that time of the administrative authorities of Colorado to completely appropriate for Colorado's use this water which formerly passed across the state line into Kansas.

It is on the basis of the foregoing facts, and in order to present more clearly to this court the exact situation facing the Kansas irrigators, that defendants in Exception 3, which with some changes in wording with respect to the language used by the Master in the second para-

graph of the third Finding of Fact, have requested that there be found as an addition the following:

> "and with the construction of the channel reservoir known as the Caddoa Reservoir now completed to the extent of storage of 270,000 acre-feet, and with ultimate storage capacity of 655,000 acre-feet, the larger portion of the water supply hitherto passing across the state line into Kansas can be captured and conserved in said Caddoa Reservoir."

G. EQUITABLE APPORTIONMENT

(Relating to Exceptions 7, 9, 11 and 12, and Exceptions 1 and 2 to the Recommended Decree)

The Master, having found the average dependable water supply of the basin to amount to 1,110,000 acre-feet (Finding of Fact 6), arrived at an equitable apportionment of such supply on the basis of 925,000 acre-feet to Colorado and 185,000 acre-feet to Kansas, of which 150,000 should be delivered between April 1 and October 1, 35,000 between October 1 and April 1 (Findings of Fact 8 and 9). He likewise found that in the event of a deficiency or increase in the flow of the River and its tributaries, the supply should be pro-rated in relation to the dependable average amount awarded to Colorado and to Kansas (Findings of Fact 8 and 9).

Since it is an undisputed fact that the water supply is a constantly varying amount, proration on the basis of the equitable apportionment can be maintained only by a definite provisions for the ratio of division to be maintained at all times. It is clear that in Finding 8 the Master has awarded five-sixths of the average annual dependable supply to Colorado; it is likewise apparent that he has awarded one-sixth of the average annual dependable supply to Kansas. Therefore, in order to permit the administrative control to properly pro-rate the supply as it fluctuates, defendants have requested that the percentages, namely 83.33 percent and 16.67 percent, be included in the Master's findings in order that a fixed ratio can be maintained dealing with any given quantity of water at any particular time.

Defendants also in these exceptions have requested a modification of certain language which we believe was inadvertently used in Finding 9, and Conclusion of Law 3, in order that it may be reconciled with paragraph 2 of the Proposed Decree. The court will note that in paragraph 2 of the Proposed Decree the language is clear that the 185,000 acre-feet allocated to Kansas should be delivered at such times and in such amounts

as and when required by water officials of the State of Kansas.

Inasmuch as the 185,000 acre-feet allocated to Kansas is approximately 75,000 acre-feet less than the average annual amount passing across the state line in the past, but which was largely unusable as heretofore pointed out in this brief, it is apparent that it was the intention of the Master that this smaller quantity should be made usable by having it delivered in conformity with irrigation needs on demand of the Kansas state water officials. This was considered easily feasible, because the construction of Caddoa Reservoir across the channel of the River added to all other existent reservoir storage in Colorado. Most of the hitherto uncontrolled flood waters would be subject to capture and control within the confines of the State of Colorado. However, in both Finding 9 and Conclusion of Law 3 this ambiguous language has been used: "at such times and in such amounts of the 35,000 acre-feet as the same could be delivered for irrigation or storage when required by the water officials of Kansas." This might be construed by some to mean that only the winter water would be delivered on demand of the water officials.

While storage, or even recharging of ground water, might be possible from the winter delivery, it is absolutely certain that the same never could be delivered to serve the purposes of irrigation, and the use by the Master of the words "delivery for irrigation when required by the water officials" indicates that the deliveries on such basis relate to the entire annual supply. However, since the language is meaningless, defendants have asked for the deletion of the words "of the 35,000 acre-feet as the same could be delivered for irrigation or storage when," in order that the language will conform to paragraph 2 of the Proposed Decree.

In the light of the previous portions of this brief relating to the present character of the water supply, unless delivery can be compelled by the water officials of Kansas of their portion of the supply in conformity with irrigation needs, all that Kansas would receive would be a continuation of a few flash floods.

H. REQUIREMENT OF DECREE WHICH WILL PROTECT AND INSURE DELIVERY AT THE STATE LINE OF KANSAS' SHARE IN ACCORDANCE WITH IRRIGATION REQUIREMENTS

(Relating to Exceptions 10 and 13, and Exception 3 to the Proposed Decree)

1. Method to Be Used

The Master has determined the equitable apportionment of the water supply of the Arkansas River basin, five-sixths to Colorado and one-sixth to Kansas. The requested inclusion of 83.33 percent to Colorado and 16.67 percent to Kansas fixes a ratio, whereas the same apportionment may be maintained in distribution of a fluctuating water supply.

We now turn in this section of the brief to a discussion of the more complicated problem of how delivery of the apportioned supply to Kansas can be made in such manner as to insure water users in the lower state the same degree of utility for irrigation as that enjoyed by the upper state. As has been shown in this brief, mere quantity of water is valueless, unless the same is made available in conformity with crop requirements. The Special Master has dealt with this problem in Finding of Fact 12, Conclusion of Law 5, and paragraph 8 of the Proposed Decree. Clarification of the language used

therein has been raised by defendants' Exception 10 at page 11, Exception 13 at page 17, and Exception 4 at page 24 to the Proposed Decree. This problem of delivery is complicated by four factors:

1. Colorado, as the upper state, has the first opportunity to divert the usable water to satisfy existing demands, and if delivery to Kansas is to be protected such Colorado uses must be placed under definite and clear administrative restraint.
2. Colorado's ditch decrees for diversion are in terms of second-feet, thus a ditch with a decree of 200 second-feet may divert that amount of flow each day in its order of priority as long as there is any water flowing in the channel of the stream.
3. Colorado reservoirs also divert such water as remains which can be captured, and then hold the same for use in Colorado.
4. Some 195,000 acres of land are irrigated on the tributaries with water which, because of such use, never is permitted to reach the main channel of the stream so as to be measurable as stream flow.

Such acreage under irrigation in 1930 is reflected in Kansas' Exhibit 57, R. page 1513, and Kansas Exhibit 24, R. page 1462:

Water District 12	*Acres*
Tributaries below Canon City	11,000
Fountain	20,300
St. Charles	10,700
Huerfano	53,200
Apishapa	5,700
Purgatoire	39,500
Main valley side streams	12,600
Irrigated above Canon City	42,800

Because of these factors any decree entered by this court must protect deliveries to Kansas against the depletion possibilities of the foregoing factors, if the water apportioned to the lower state is to be delivered at the state line.

There are as defendants view it only two practical and permanent methods of insuring the delivery of its equitable apportionment as dependable flow to Kansas. The first method is by a definite interstate water schedule, specifying water deliveries month by month in accordance with past river performance and irrigation demands (R. 1744). In support of this solution an interstate water schedule, namely Schedule C, was submitted in evidence, being Kansas Exhibit 99, R. page 1750, which was based upon an equitable apportionment of 24 percent of the average yearly water supply, and but 27 percent of the average yearly dependable flow. This exhibit is as follows:

January and December, approximately in round figures	50 second-feet
February	110 second-feet
March	145 second-feet
April	250 second-feet
May	730 second-feet
June	1,250 second-feet
July	970 second-feet
August	480 second-feet
September	350 second-feet
October	190 second-feet
November	100 second-feet

However, reduced to terms of 185,000 acre-feet, or 16.67 percent of the average dependable supply, the amount allocated to the State of Kansas by the Special Master, the monthly delivery schedule would appear as follows:

Month	*Av. Flow (sec. ft.)*	*Monthly Totals (ac. ft.)*
January	32.7	2,010
February	71.9	3,995
March	94.8	5,830
April	163.5	9,726
May	477.3	29,351
June	817.3	48,632
July	634.2	39,000
August	313.9	19,300
September	228.9	13,617
October	124.2	7,639
November	65.4	3,890
December	32.7	2,010
Total		185,000

The difficulty with this method is that it provides deliveries in constant amounts each year to Kansas, re-

gardless of the quantity of the fluctuating water supply. Applying the operation of this schedule to the determined Colorado water supply from 1895 to 1930 (Kansas Exhibit 70, found at page 77 of this brief, it would operate adversely to Colorado in 12 years of the 36-year period, when the water supply fell below the average annual dependable supply, and would operate adversely to Kansas in the 22 years when the water supply was above the average annual dependable flow.

The Master did not adopt this comparatively simply administrative method of protecting and insuring delivery to Kansas in favor of a plan of delivery whereby the burden of dry years would be borne by each state in the same proportion as the equitable distribution of water was decreed (Finding of Fact 12). The equity of this method is apparent, but the administrative problem of determining the water supply of the entire basin, which is subject to division, and providing for its delivery each day as it originates is somewhat complicated and requires the clearest definition of its details in the decree, if the equitable apportionment prescribed by the Master is to be preserved and the ratio of delivery insured.

While the ultimate determination of the original water

supply of the basin, annually, monthly, or even daily, is a comparatively simple engineering problem, and has been most accurately ascertained in this case over a period of 36 years, it requires time, the assembly of innumerable records, and an engineering staff, which would introduce a considerable time lag in the ascertainment of the facts, and would make such character of determination impractical and too expensive from an administrative standpoint.

If water is to be delivered each day, the amount available for delivery must be determined each day and protected against upstream consumption. Again, if we approach the problem from the standpoint of the actual measure of water as it originates, even innumerable gauging stations recording the flow would not be able to measure the actual water supply of the basin, since irrigation on the tributaries to the extent of 195,000 acres (see Kansas Exhibits 57 and 24 heretofore referred to) would have consumed a considerable part of the supply before the same ever reached the main channel of the stream, and likewise innumerable small tributaries contributing surface runoff throughout the basin would escape accurate measurement.

However, a solution to this problem of determining

the daily water supply as it originates exists which is practical and fairly inexpensive from an administrative standpoint. This can be accomplished by the selection of two gauging stations having long time records, where the relationship of the flow passing those stations to the total basin water supply can be ascertained with reasonably accuracy. Such stations can be selected so that they serve as an index of the water supply of the basin as it originates (R. 7016), and from which the total basin water supply can be computed.

This is the plan adopted by the Special Master, and is shown in the Master's Finding of Fact 12, the first part of which reads as follows:

> "The water supply of the basin comes from two distinct sources, the mountain water supply and the plains water supply, the first is irregular in its occurrence as the rise of the streams occurring with melting snows and the other, or plains runoff being erratic, sometimes large and sometimes small. (*R. 7016.*) Two designated measuring points should be established, one of which will serve as an index of mountain water supply and another station selected which will serve as an index of the plains water supply. The water measured at those stations will vary up or down as those two types of the water supply in the basin varies (*R. 7017*) and the burden of benefits of wet years and dry years would be borne in the

same proportion as the equitable distribution of water supply is decreed." (Italicized record pages ours.)

Naturally the stream flow passing such stations will represent only a portion of the total water supply of the basin, since irrigation uses above and on all the tributaries, together with all inflow below them, will not be there recorded. However, with the ratio which the water supply passing these stations bears to the total basin water supply over a long time period, a known factor, it becomes a comparatively simple matter to compute or determine from the measured water passing these index stations the total water supply of the basin, and from the quantity so computed or determined effectuate the apportionment of 83.33 percent to Colorado and 16.67 percent to Kansas. This would insure to Kansas water users the same character of supply as that of Colorado, since the division would be based upon the water supply as it was produced.

Defendants' Exception 10 at page 11 to the Master's Finding of Fact 12, Exception 13 at page 17 to Conclusion of Law 5, and Exception 3 at page 22 to paragraph 4 of the Proposed Decree, are not directed to the plan found by the Master as the desirable one to be em-

bodied in a decree, but the exceptions are directed to some of the language used which is susceptible of misinterpretation unless the ratio which the water passing the two index stations selected bears to the total water supply to be determined, so that from an administrative standpoint the manner in which the flow passing such two stations is to be used to compute the water supply subject to division is clearly shown.

The stations selected by the Special Master, namely, Canon City where the Arkansas River emerges from the Royal Gorge, and the Purgatoire River at its mouth, were those taken from Kansas Exhibit 134, R. page 7019, which is here set out in full for the sake of ready reference.

A Suggested Permanent Method of Division of the Water Which Will Also Protect Storage in and Utilization of Caddoa Reservoir through Key Measuring Stations Above

ACRE-FEET

Year	Corrected Arkansas River at Canon City	Purgatoire River at Mouth (Col. Ex. 204)	Total	Fifty Percent of Total
1908	396,271	83,631	479,902	239,951
1909	701,970	155,120	857,090	428,545
1910	567,408	77,386	644,794	322,397
1911	701,618	42,723	744,341	372,171
1912	671,535	89,740	761,275	380,637
1913	685,752	31,926	517,678	258,839
1914	721,900	204,360	926,260	463,130
1915	546,000	174,260	720,260	360,130
1916	685,620	61,524	747,144	373,572
1917	670,580	61,805	732,385	366,192
1918	636,920	79,870	716,790	358,395
1919	639,250	103,530	742,780	371,390
1920	688,640	71,179	759,819	379,910
1921	717,850	84,556	802,406	401,203
1922	560,310	25,700	586,010	293,005
1923	701,890	390,404	1,092,294	546,147
1924	671,000	54,611	725,611	362,805
1925	427,900	89,556	517,456	258,728
1926	547,540	84,970	632,510	316,255
1927	600,700	204,774	805,474	402,737
1928	569,430	115,235	684,665	342,333
1929	628,420	131,644	760,064	380,032
1930	521,200	119,383	640,583	320,292
1931	342,349	58,801	401,150	200,575
1932	518,097	22,834	540,931	270,466
1933	448,698	67,234	515,932	257,966
1934	310,238	29,822	340,060	170,030
1935	515,306	69,025	584,331	292,166
1936	627,419	66,756	694,175	347,088
1937	416,220	72,479	488,699	244,350
1938	554,850	64,070	618,920	309,460
Average	573,964	96,416	670,380*	335,190

* 670,380 acre-feet is between 52 percent and 54 percent of the average yearly water supply of the basin in Colorado—1,240,000 to 1,290,000 acre-feet—Kansas Exhibit 63.

It will be noted that the long time average amounts to 670,380 acre-feet, and that this represents 54 percent of the average annual water supply of the basin found by the Master to amount to 1,240,00 acre-feet. The difference between these two amounts represents that portion of the water supply which is consumed in Colorado by irrigation uses above the two selected index stations, or which flows into the stream below such stations through the other numerous tributaries in Colorado contributing to the basin supply.

Since the water supply, therefore, passing these two stations represents but only 54 percent of the average annual supply as it originates, these two stations taken together constitute an index, and an index only, on the basis of which on any given day or period the water supply, subject to division and allocation between the states, can be determined by computation. One-sixth of the amount so determined is the water supply deliverable to the State of Kansas at the state line, in accordance with the apportionment made by the Special Master, and five-sixths becomes immediately available for Colorado use.

The difficulty with the Special Master's finding is that it does not clearly reflect what percentage of the measured water passing such index stations will equal the

percentage of the total supply allocated for delivery to Kansas. Since the two index stations represent only 54 percent of the total water supply of the basin, then in order for Kansas to receive 16.67 percent of the basin water supply in accordance with the Master's apportionment, 30.87 percent of the water supply passing the two index stations represents the deliverable amount to Kansas when and as the supply accrues. For example: If we assume that in a given year 500,000 acre-feet of water passes the two index stations, since this amount represents 54 percent of the basin water supply the total basin supply in that particular year would amount to 925,900 acre-feet. This divided between the two states according to the apportionment made by the Special Master of one-sixth to Kansas and five-sixths to Colorado, would mean that approximately 154,000 acre-feet would be deliverable at the Kansas-Colorado line for Kansas use, and 771,000 acre-feet would be available for Colorado use. Or, if we use the definite index figure of 30.87 percent of the supply passing the index stations, we arrive at the same apportionment, namely 154,000 acre-feet to Kansas and 771,000 to Colorado.

It will be noted that this is a lean water year, where, as reflected in the Master's Report, the burden would be

borne by each state in accordance with the ratio of apportionment. On the other hand, let us assume that the water supply passing the index stations amounted to 800,000 acre-feet. Since this represents 54 percent of the total water supply, the water supply would be computed at 1,481,400 acre-feet. The deliverable amount to Kansas would amount to 246,900 acre-feet, or one-sixth; the amount available to Colorado 1,234,000 acre-feet, or five-sixths. Or, to use the index ratio of 30.87 percent, we find exactly the same result of 246,000 acre-feet to Kansas and 1,234,000 to Colorado. The effectiveness of this method of determination is that from an administrative standpoint the quantum of deliveries to Kansas can be determined each day as the water supply originates and ample protection afforded.

Again for illustration: Assuming that on a given day the water supply passing the index stations amounted to 4,000 acre-feet. That amount being 54 percent of the water supply of the basin, we would have available approximately 7,400 acre-feet for irrigation purposes. One-sixth of this would be the equitable share subject to delivery to Kansas, or 1,240 acre-feet, with 6,160 acre-feet available for Colorado use. Or, to use the index ratio of

30.87 percent of the index flow, the deliverable portion to Kansas would amount to 1,240 acre-feet.

It is apparent from the Master's Finding of Fact 12 at page 12, and his Conclusion of Law 5 at page 16, that this index station method which we have here explained is the method which the Master felt would adequately protect deliveries to Kansas in conformity with the water supply as it originated, so that Kansas would have the benefit of a flowing stream. Defendants' exceptions directed to these findings are not with respect to the method, but only seeking to clarify the language, and provide for the definite percentage of the flow passing the two index stations, which will insure a delivery of the one-sixth of the water supply determined by the Master to be Kansas' equitable share. Defendants have accordingly suggested that the Master's Finding of Fact 5 be modified as follows:

> "There is required to be established by the states of Colorado and Kansas ~~three~~ modern measuring devices at *two* stations *herein named, which shall be used* to accurately measure the *flow* of water *passing such stations* ~~supply of the Arkansas River and the flow of the river and its tributaries~~, one of which is to be located at a station at Canon City, Colorado and one to be located near the mouth of the Purgatoire River. *The recorded flows of water pass-*

ing such two stations shall serve as an index from which may be computed for the purpose of apportionment the total water supply of the Basin when and as the same originates. Thirty and Eighty-seven hundredths percent (30.87%) of the water passing such station, which is sixteen and sixty-seven hundredths percent (16.67%) of the total Basin water supply, shall be the amount of water which accrues to Kansas as its equitable share and which is subject to delivery at the state line, and an equivalent amount of water shall, after the same accrues, be delivered by the State of Colorado at the state line as required by the Kansas state water officials. ~~and another~~ A third station ~~shall be established~~ where the water shall be accurately measured, located on the river at the Colorado-Kansas state line to ~~determine~~ *record* the amount of water ~~flowing in the river that should be~~ delivered to the State of Kansas *day by day pursuant to the apportionment herein determined as such water supply is computed through the use of said index stations as having accrued for delivery to Kansas, but the amounts of water passing such station in daily amounts larger than the accrued amounts as shown by said index stations, shall be classed as flood waters and shall not constitute a delivery under the allocation herein unless the same shall have been made pursuant to the request of Kansas state water officials.* ~~and~~ The expense of the construction and operation of the measuring devices shall be equally borne by the states of Colorado and Kansas, and in the event the two states are unable to agree upon one to so construct and operate the same, then the court should appoint someone to construct and

operate such measuring devices." (Defendants' Exception 13, pages 18 and 19.)

While the foregoing discussion of the use of the index percentage to determine the water supply relates to the most important modification of Finding of Fact 12, three other modifications are embodied in defendants' exception to this finding.

2. Recording of Water Deliveries to Kansas at the State Line

The first of these relates to a clarification of language concerning the purpose and use of the measuring station at the Kansas-Colorado line. Respecting this station the Master used the following language:

> "And another, a third station, shall be established where the water shall be accurately measured located on the River at the Colorado-Kansas state line to determine the amount of water flowing in the River that should be delivered to the State of Kansas."

This language is ambiguous and confusing. Such designated station, located below all Colorado irrigation uses, could not possibly be used to determine the water which should be delivered to the State of Kansas. It obviously represents the control point to record the amount of water that is actually delivered to Kansas in conformity

with the apportionment computed by the use of index stations.

Of the three stations designated by the Special Master, the two stations located at Canon City and near the mouth of the Purgatoire are designated as index stations. They are used for the purpose of computing the water supply as it originates in order to ascertain the amount of water Colorado is obligated to deliver at the state line to effectuate the equitable apportionment decree. These two stations therefore serve the entire purpose of computing the water that is to be delivered. But the third station located on the River at the Colorado-Kansas line is for the purpose of ascertaining by the flows passing such station whether the deliveries have been made.

Defendants have therefore requested that the Master's language relating to the station at the Colorado-Kansas line be clarified in conformiy with the foregoing discussion by stating:

> "A third station should be located, and a measuring devise established, at or near the Colorado-Kansas state line to measure the amount of water as herein apportioned which is delivered to the State of Kansas, such deliveries to be measured day by day as the basin water supply originates and is computed through the use of the said two index stations."

3. Delivery of an Equivalent Amount Equal to Kansas' Share Computed at Index Stations

The second modification suggested by the defendants to Finding of Fact 12 is indicated by the last portion of the following sentence:

> "30.87 percent of the water passing such station, which is 16.67 percent of the total basin water supply, shall be the amount of water which accrues to Kansas as its equitable share, and which is subject to delivery at the state line, and and equivalent amount of water which, after the same accrues, be delivered by the State of Colorado at the state line as required by the Kansas state water officials."

What is obviously desired from an administrative standpoint is to secure the most effective use of water in Colorado commensurate with adequate protection to Kansas of a delivery of its equitable share as a usable supply in conformity wtih irrigation needs. The index stations are used for the purpose of computing the water supply as it originates, and for determining the amount which accrues to Kansas for use therein, and with respect to which Colorado is charged with the delivery thereof.

30.87 percent of the water recorded at the index station therefore becomes a credit item on the Kansas ac-

count, which Colorado is obligated to deliver to Kansas as it originates. However, a very considerable amount of the water supply available for irrigation uses passes into the stream below the index stations. But these stations having served their purpose in determining the daily deliverable quantity of water, Colorado should be able to make such delivery from any other water flowing in the stream which may be available for such purpose. There are three such available sources below the index stations. (1) Very considerable quantities of water pass into the stream through tributary inflow. (2) Large quantities of seepage and return flow, resulting from irrigation uses along the main stem of the stream to the amount of 214,000 acre-feet (Kansas Exhibit 32, R. 1483-84) return to the stream for further use. (3) Likewise, it is clear that there is tremendous storage capacity available in Colorado below the index stations. In the Caddoa channel reservoir alone a considerable portion of the flash floods hitherto passing across the state line will be impounded and controlled, and thus serve as a back log of water resource available to satisfy deliveries of water to Kansas as the same accrues. The Colorado administrative authorities will find that the amount credited for delivery to Kansas can be

satisfied from water originating or impounded lower down on the stream, thus permitting their full use of such water as might pass the index stations. For these reasons it appears desirable that it be made plain in any finding that the amount which accrues to Kansas may be satisfied by the delivery of *an equivalent amount of water after the same accrues, as reflected by the index computations.* However, if Colorado is to have the right to withhold water in the interest of a more efficient administration, then on demand of the Kansas water officials such water should be compelled to come down the stream for delivery at the state line upon demand of the Kansas water officials up to the extent which the index stations indicate have accrued to the credit of Kansas use. This reflects the manifest intention of the Master, as indicated by language used in paragraph 2 of the Proposed Decree, where the allocation to Kansas is required to be delivered to Kansas at the Colorado-Kansas state line at such times and in such amounts as and when required by water officials of the State of Kansas.

4. Protection to Kansas Apportionment Against Being Satisfied by Unusable Water through Flash Floods

As has heretofore been pointed out in this brief, flash floods passing across the state line contribute in some instances large volumes of water which are unusable for irrigation purposes. While the operation of Caddoa reservoir may capture a considerable portion of this unusable flood water, and make it usable upon release, still there are bound to be in isolated years some floods which originate below the dam site, which would put large quantities of unusable water across the state line without it serving any irrigation purpose.

With the small apportionment, obviously intended to be usable water, made to Kansas by the Master, any decree entered should afford adequate protection to Kansas against large flash floods contributing large quantities of unusable water, so that such could not be charged as a delivery against the Kansas accrued amounts. To meet this situation we believe fairly, defendants have requested in the modifications to the Master's Finding of Fact 12 the following language:

> "Daily amounts passing state line stations in quantities larger than the amounts computed from the index stations as accruals for delivery shall

> be classed as flood water and shall not be considered as a delivery under the allocation herein."

As can readily be seen, this modification in no sense destroys the effect of such usable amounts as may be captured from such flood flows, since such suggested modification expressly provides for a delivery charge up to the extent of the daily usable flow accruing to Kansas as computed from the index stations.

Inasmuch as defendants' Exception 13 to the Special Master's 9th Conclusion of Law, and Defendants' Exception 3 to paragraph 4 of the Proposed Decree, embodied the same language and relate the same character of modification, the foregoing argument applies with equal force to these exceptions and will not be repeated.

I. WHY ENJOIN KANSAS?

(Relating to Exception 14, page 19, and Exception IV, to Recommended Decree, page 24)

The Master in his 9th Conclusion of Law has used the following language:

> "That the States of Colorado and Kansas and each of them and their officers, agents, representatives and employees are perpetually enjoined from diverting and using any water from the Arkansas River and its tributaries in excess of the amounts awarded and herein decreed to them."

Substantially the same language is used in paragraph 8 at page 22 of the Recommended Decree. The defendants have requested that reference to Kansas be eliminated therefrom. These two exceptions are not of outstanding importance. They are interposed merely to remove from any decree what to defendants seems an utter inconsistency.

It should be apparent that, with Colorado as the upper state and having the first water opportunity, the State of Kansas will never be able to divert or use water from the Arkansas River, except as the same by force of the decree entered by this court is protected in its delivery against depletions in Colorado which destroy its effectiveness for irrigation uses. Water runs down hill, and Kansas never has nor never will be able to use water in excess of any amount decreed by the court as against the rights of Colorado. The shoe is on the other foot. The perpetual injunction against using water in excess of the decreed amount is a protective measure directed against Colorado, its officers, agents, representatives and employees, in order to protect the deliveries to Kansas in conformity with the decree entered by this court; and defendants merely suggest that an inconsistency of this character, which would indicate a failure

to visualize the true relationship between the upper and lower state, should not find its way into a formal decree entered by this court, even though in practical effect it could never be operative against a commonwealth, which physically is not in a position to ever deplete the waters of the Arkansas River to the detriment of the upper state.

V. CONCLUSION

It has been impossible in this brief to discuss in detail the 39 volumes of evidence and 368 exhibits, some of which contain many pages. The Special Master appointed by this court had the fullest opportunity over the period of nearly a year, and after several days argument by counsel, to weigh this evidence and formulate his report. Defendants assume that, except for basic error, his fundamental findings will not be disturbed by this court. These basic findings, which are amply supported by the evidence, and to which the defendants have filed no exception, are as follows:

1. That the average annual dependable water supply which is subject to apportionment amounts to 1,110,000 acre-feet.

2. That since the taking of testimony in the old Kansas-Colorado case there has been a material increase in the River depletion by Colorado, which has diminished the flow of water into the State of Kansas to the injury of substantial interests in Kansas.

3. That the water supply of the Arkansas basin should be apportioned on a basis of five-sixth to Colorado and one-sixth to Kansas.

4. That the annual supply subject to division should be computed by the use of two index stations designated by the Special Master, so that the division of such ascertained amount could be made as the water supply originates, in order that the burden of dry years and the benefit of wet years would be borne in the same proportion as the equitable distribution of the water supply is decreed.

As hereinbefore stated denfendant's exceptions relating to a modification and clarification of ambiguous and uncertain language therein, are made in order that the manifest intent of the Special Master as reflected in his report could be embodied in the decree with such clarity that the possibility of future disputes respecting its interpretation would be eliminated.

The additional findings of fact, which have been requested in defendants' exceptions, are facts which the Master clearly had before him in his consideration of the evidence. The Master probably felt that these facts were mere stepping stones to his ultimate conclusion, and were therefore not essential for embodiment in his report. Defendants have felt the necessity of presenting to this court through their request for additional findings, the same basic picture as that considered by

the Special Master. This has been done in order that in the clarification of language the manifest intent of the Special Master be preserved, and at the same time adequate protection be afforded to the State of Kansas by the decree, whereby the delivery of a lesser amount of water than now passes across the state line would be insured in conformity with irrigation needs, and likewise in order that this controversy should be adjusted as this court has indicated "upon the basis of equality of rights as to secure as far as possible to Colorado the benefits of irrigation without depriving Kansas of the like beneficial effects of a flowing stream."

In conclusion we suggest that the record proves conclusively:

(1) That the need for irrigation in the arid regions in Western Kansas and in Eastern Colorado is equal.

(2) That under natural conditions agriculture in this region in both states produces the same crops with substantially equal results.

(3) That Colorado's contention that except for irrigation her lands in the Arkansas basin in Colorado cannot support agriculture has been disproved by the actual production of crops on over 1,000,000 acres farmed under dry land conditions.

(4) That the need for water from the Arkansas River for irrigation in order to produce crops of high water requirement, and to secure more satisfactory yields of all crops, was recognized in both states, and the large irrigation enterprises started at substantially the same time in order to realize such benefits.

(5) That Colorado's water users, having the opportunity to utilize and consume the stream flow before it passed into Kansas, have exercised such opportunity so that the only water that escapes across the state line into Kansas are flash floods originating in the lower reaches of the River in Colorado.

(6) That Colorado has consumed and destroyed, and thereby depleted, the water supply of the basin to the extent of at least 85 percent of the average annual supply amounting to 1,240,000 acre-feet or more; and that Colorado has consumed, destroyed and depleted the average annual dependable flow of approximately 1,110,000 acre-feet to the extent of 95 percent.

(7) That stream flow into Kansas across the state line has become so depleted and diminished as to deprive Kansas of any practical benefits from the use of such water, and this is indicated by the fact that the records show that during the months of May to September inclusive

during the span of years from 1912 to 1931 (3,060 days) there were 2,123 days when the flow in the stream crossing the state line was 200 second-feet or less, and of these in 1,359 days there was less than 50 second-feet of flow available for irrigation use.

(8) That Kansas' right to the beneficial use of water from the Arkansas River based upon her equality of right as a sovereign state is measured by a need for such water equal to that of Colorado, and is not determined by any limited use heretofore made which has been imposed upon Kansas water users through Colorado's wrongful depletion.

(9) That the water supply of the Arkansas River is now almost completely controlled in Colorado through the use of reservoirs heretofore constructed and by the Caddoa reservoir now in the process of completion, so that from this time forward practically no water will be able to pass into Kansas except such as is adjudicated to Kansas as her right by a decree of this court.

(10) That Kansas can be protected in the enjoyment of benefits from the flow of the Arkansas River and the development of irrigation enterprise which she is rightfully entitled to enjoy only by a decree which adjudicates to Kansas her equitable share of the flow of the river in

such terms and under such conditions as will compel delivery at the state line of such flow in amount and continuity as bears an equitable relationship to her needs and her rights.

Respectfully submitted,

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